THE BOOK OF THE AQUARIUM

BY

SHIRLEY HIBBERD

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THE BOOK

OF

THE AQUARIUM;

OR

PRACTICAL INSTRUCTIONS

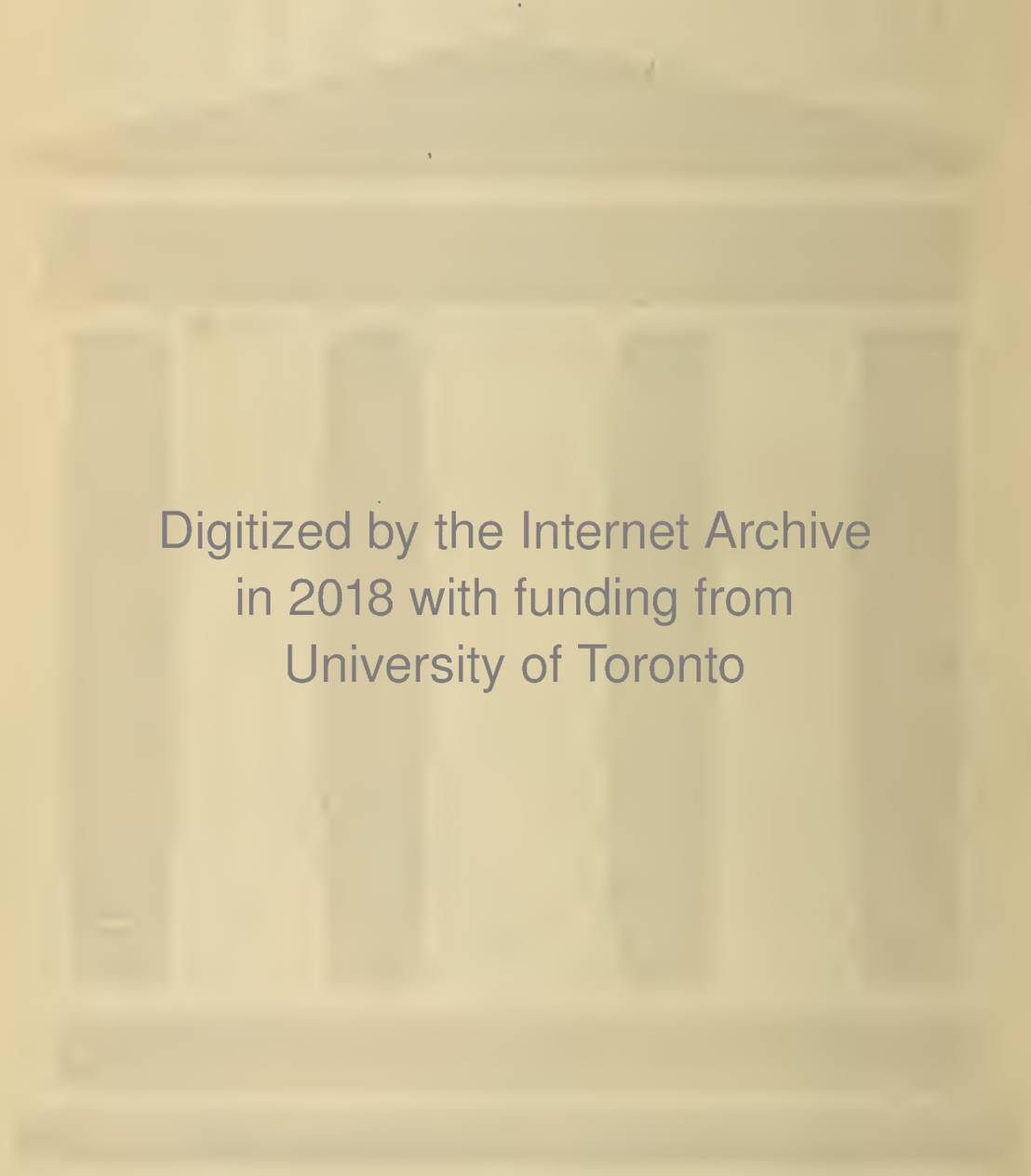
ON THE FORMATION, STOCKING, AND MANAGEMENT IN ALL SEASONS, OF COLLECTIONS OF MARINE AND RIVER ANIMALS AND PLANTS.

BY SHIRLEY HIBBERD,

AUTHOR OF "RUSTIC ADORNMENTS FOR HOMES OF TASTE," ETC., ETC.

NEW EDITION, REVISED AND ENLARGED.

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THE

FRESH-WATER AQUARIUM.

PREFACE.

SINCE the first edition of this work was issued, many important changes have passed over the Aquarium; difficulties which appeared at that time insurmountable, have been vanquished, and the safest and most certain methods of procedure have been improved. As the first writer of a consecutive treatise on the Fresh-water Aquarium, it is with no ordinary pleasure that I now offer the public a thoroughly revised and enlarged edition of this work, which, since its first issue, has been several times reprinted, and has had the largest sale of any work of its class. I never intended to treat the subject in a strictly scientific manner, and have not aimed at anything more on the present occasion than to state in the plainest possible terms the rationale of management from first to last, and to indicate, rather than describe, the various forms of animal and vegetable life which are admissible to aquaria. My desire has been to produce a safe guide for beginners, and one which should also contain advices worthy of the consideration of adepts, and I confidently believe that the chapter on the natural history of tank management will commend

itself to those who have had equal experience in the subject with myself.

The former editions of this work have been pirated wholesale, and in my own defence I must warn the gentlemen who exercise themselves so wantonly with scissors, that I am not disposed to be so patient with them in the future as I have been in the past. One monthly work I well remember, extracted an entire chapter, and attached to it the name of a dealer in toads, who can scarcely write his own name. An expostulatory letter to the editor brought me neither private apology nor public avowal of the theft. Others have extracted simply without acknowledgment, and have appeared very creditably as Aquarian philosophers, without charging themselves with the labour, patience, and expense which I have incurred in obtaining a practical knowledge of the subject. Henceforth I shall hold to the rights given by the law, and visit the plagiarists with a proper reward of their deeds.

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THE FRESH-WATER AQUARIUM.

THE mosses of thy fountain still are sprinkled
With thy Elysian water-drops: the face
Of thy cave-guarded spring, with years unwrinkled,
Reflects the meek-eyed genius of the place,
Whose green, wild margin now no more erase
Art's works; nor must the delicate waters sleep,
Prison'd in marble, bubbling from the base
Of the cleft statue, with a gentle leap
The rill runs o'er and round fern, flowers, and ivy creep.

BYRON.

CHAPTER I.

HISTORY OF THE AQUARIUM.

INTRODUCTORY.

STUDIES of animated nature have been pursued with increased ardour and success since the establishment of the Aquarium as an invaluable aid in

such pursuits. Vast regions of animal and vegetable life, the mere existence of which was known to but a few of our leading naturalists ten or fifteen years ago, are now explored by thousands of patient observers; and the wonders of the brook, the river, and the mysterious sea have become familiar things among persons of intelligence and scientific inquiry, who, without the help of the Aquarium, must, for lack of leisure and means, have remained content with brief technical descriptions conveyed in ponderous books, to the perusal of which there would have been no sympathies to attract them. The Aquarium created a taste for deep-sea studies, and then fed that taste with wholesome truths. By giving delight to the eye as a domestic toy, and by stimulating through the medium of recreation the spirit of scientific inquiry, it has brought subjects of profoundest interest within the practical reach of the humblest student of the ways of God in Nature. It is the fashion of the age to give a hearty welcome to whatever increases the elegance of a home by the introduction of natural objects for purposes of adornment and the progress of horticulture: the increased demand for horticultural books affords evidence as to the healthy growth of domestic life in England, of a precisely similar kind to that furnished by the increasing popularity of the Aquarium. It is quite true that when the Aquarium first became popular, it had, like all new things, to pass through an ordeal, in which it would be hard to say whether its friends or enemies did most to retard its progress. The errors that were promulgated by pretenders, and the mistakes of practical cultivators, who were not yet aware of the nature or limits of the resources at their command, combined against it unwittingly; and many who were momentarily seized with the "Aquarium mania" got perplexed in their first efforts, and then gave it up in

despair. In every art, science, and pursuit, a certain class of shallow-minded persons will from time to time blunder in and blunder out again, to pronounce the subject of their temporary choice a delusion and a snare. But the mind capable of recognising the principles on which any pursuit is based, does not allow trifling difficulties to stand in the way of ultimate success; and by the perseverance of such the Aquarium has become established as a triumph of Art acting as the handmaid of Science.

If the Aquarium be managed on philosophical principles it at once removes the veil that formerly enshrouded the wonders of aquatic life from the popular eye, and opens the door of discovery to the searcher after knowledge. The scientific observer and the cultivator of agreeable recreations, now agree in regarding the Aquarium as a valuable means of bringing together many curious objects from various departments of nature; and among intelligent persons there is spreading a passion for natural history pursuits, for which the Aquarium is entitled to all the credit. Seeing how much has been accomplished during the past few years it is impossible to avoid regrets that the Aquarium was not known long since, when physical science commenced the march of triumph under the guidance of the inductive method. What a store of valuable information would it have furnished to Mr. Yarrell for the enrichment of his work on fishes? How many of the mistakes of Professor Johnstone would have been corrected had he possessed such means as we now have for the study of zoophytes? And how much earlier would have been dissipated the doubts that long hung like dark clouds over the classification of Infusoria, and the question as to animal or vegetable among various divisions of the Protozoa, had the important *balance* of forces been

earlier arrived at? How poor the resources of the microscopist in the absence of a reservoir to gauge with the dipping tube; how unsatisfactory the researches of the marine phytologist without the help of a tank in which to note the effects of light on Algæ; how narrowed the field of labour for botanist and zoologist alike without such a means of having always at hand living specimens of the least known but most interesting and perhaps most common aquatic plants and animals.

THE PROBLEM OF THE AQUARIUM.

The Aquarium exemplifies, in an instructive manner, the great system of compensation which, in nature, preserves the equilibrium of phenomena in animal and vegetable life. Indeed the recent adoption of this plan of studying the characteristics of creatures hitherto placed beyond our reach, except when dead and mutilated, has arisen out of the experiments of philosophers as to the nature of that duality of forces which renders the two great departments of organized existences essential to each other, not merely for ordinary sustenance, but for the continuance of refined chemical operations essential to their respective organisms. Researches into the chemistry of animal and vegetable bodies, and especially of the effects they severally produce, by respiration, on the medium surrounding them, have resulted in the conclusion that animals and vegetables supply each other with the gases most essential to existence; what the one exhales as effete and obnoxious, the other absorbs for the highest uses of vitality. Animals take oxygen from the medium in which they live, and in return exhale carbonic acid. Vegetables also absorb oxygen gas, and give out carbon; but they absorb the latter in greater quantity than they exhale it, and during their season of greatest activity throw off more

oxygen than they take up at other times. Herein is the first element in the management of an Aquarium, which, to be successful, must contain a sufficient number of plants to supply the animals with oxygen for respiration.

PROGRESS OF INQUIRY AND EXPERIMENT.

Lavoisier was the first who, upon philosophical grounds, established the fact of this balance of influences. De Saussure, in 1780, proved that plants had a tendency to improve the atmosphere, by robbing it of the gases most baneful to animal life; and Priestly, by means of well-devised experiments, ascertained that when atmospheric air had become vitiated by combustion and animal respiration, plants had the power of restoring it to a normal condition, so as to be again capable of supporting flame, and the breathing of animals. Inglehouse and Ellis contributed to this inquiry, and modern chemistry establishes the fact, that though vegetables absorb oxygen, they do, by the decomposition of carbonic acid into its elements—oxygen and carbon—yield a large quantity of the first element to the atmosphere, while retaining the second for the construction of their tissues.

In the philosophical examination of this subject, the report of Professor Daubeny to the British Association, in 1833, is perhaps the most conclusive and elaborate of any of the contributions of modern chemists. He regarded light as operating upon the green parts of plants in such a way as to enable them to assimilate carbon and evolve oxygen; and concluded that as a very small portion of a tree or shrub generates a considerable quantity of oxygen, there were no reasons to doubt that the influence of the vegetable might serve as a complete compensation for that of the animal kingdom.

The formation of a marine Aquarium was first accom-

plished by Dr. Johnstone, one of our most successful students of marine life. In his "History of British Sponges," published in 1842, he describes the formation of a little marine Aquarium in a glass jar, containing only six ounces of sea-water, stocked with living coralines, minute confervæ, ulva, several little mussels, annelides, rissoæ, and a star-fish. The jar was placed upon a table, seldom disturbed, and after eight weeks, the water still unchanged, had lost little of its capability for the support of animal life; some of the animals were still active, and the coralline was still growing.

Dr. Lancaster in his interesting and attractive work on the "Aquavivarium," expresses an opinion that the original idea was taken from the success attending the cultivation of plants in glass cases, on the plan recommended by Mr. Ward. With this opinion I quite concur, and it is agreeable to have to associate Mr. Ward's name with the subject before us, for he was one of the early pioneers, and at a meeting of the British Association at Oxford, 1849, communicated an account of his success in growing marine algæ in artificial sea-water. In 1841 Mr. Ward established the first Aquarium for fishes and plants in his fern-house in Wellclose Square, his object being *not* to determine the counterbalancing influence of plants and animals in water —that having been ascertained long before by Priestly— but to determine whether the limited quantity of air in the fern-house would be sufficient for the well-being of the fishes. Dr. Lancaster had sticklebacks in jars containing *Vallisneria* and *Callitriche* in 1849, and from that date there commenced a little stir upon the subject among the scientific public, about which date I made my own first experiments with a collection of marine objects, gathered on the shore at Sunderland, where Peter Allan's Cave and Rock give a local and

romantic interest to those splendid cliffs of magnesian limestone.

Further experiments were made by Mr. Robert Warington, who reported upon them to the Chemical Society, in March, 1850. Two small gold fish were placed in a glass receiver of about twelve gallons capacity, covered with muslin to exclude the dust. The vessel was half filled with spring-water, with a bottom of sand and mud, and some loose fragments of limestone and sandstone, so arranged as to form shelter and shade. A small specimen of *Vallisneria spiralis* was, at the same time, planted in the mud and kept in place by a stone. "Everything when on well for a time, till it was found that the natural decay of the older leaves of the plant began to produce turbidity in the water, and a confervoid growth accumulated on the sides of the vessel, and on the surface of the water; to meet this emergency, Mr. Warington introduced a few pond snails, which greedily fed on the decaying vegetable matter and slimy mucus growth, so as quickly to restore the whole to a healthy state."

Here was a complete circle of compensating processes. The plants grew and increased by offsets, and at the same time exhaled sufficient oxygen to preserve the health and beauty of the fishes. The snails ate up the mucus, and bred rapidly: their eggs and young supplied the fishes with food. Thus the three tenants of the globe maintained each other as in any well-ordered human community; and the water preserved its purity unchanged, and the compensating powers of animals and vegetables were established.

The first marine vivarium established in London, was constructed by Mrs. Thynne, who made the experiment of bringing some living madrepores from Torquay to London, for the purpose of study and the entertainment

of friends; this was in the autumn of 1846. A stone jar was filled with sea-water; the madrepores were fixed on a large sponge by means of a needle and thread. They arrived in London safely, and were placed in two glass bowls, and the water changed every other day. But the six gallons of water brought by Mrs. Thynne, was now exhausted, and must be used again. She then devised means to freshen it for second use. "I thought of having it *aerated by pouring it backwards and forwards before an open window*, for half or three quarters of an hour between each time of using it. This was doubtless a fatiguing operation; but I had a little handmaid, who, besides being rather anxious to oblige me, thought it rather an amusement."

Thus the madrepores were supplied with air by means of the agitation of the water, into which they were to be placed, and at the expiration of three months a fresh supply of sea-water was obtained, and all went on well. This success led Mrs. Thynne to further experiments, her narrative of which is so instructive that it seems advisable to quote her own words. She says—

"In the spring of 1847, I wished to try whether I could adjust the balance between animal and vegetable life, and sent for shells and small pieces of rock, to which living sea-weed was attached. On these shells, etc., were sure to be many zoophytes and other animals, so that I obtained a very various and curious collection of marine creatures. I had a quantity of microscopic corallines, which multiplied very fast; serpulæ, that rapidly elongated their stony cases; some nereis, ophiuræ, and a great many beautiful little things for which I could find no name. On one piece of rock was the first germ of a living sponge. I watched the shooting forth of its spicula with the greatest interest. It was

very fine, and grew to the size of a hazel nut, coming to maturity in about six weeks. In the course of the next winter, from want of motion in the water, it had become so covered with dust that I did not know whether it were alive or dead; but in the following June a bright spot appeared on one side, and it threw forth a sporule which attached itself to the rock, and in about six weeks a full-grown young sponge stood beside its parent. I placed this sponge in a darkened room, and found the spicula grew most on whichever side was turned to the light. From this time I regularly placed sea-weed in my glass bowls; but as I was afraid that I might not keep the exact balance required, I still had the water refreshed by aeration. I do not know from which, or whether it was from both causes, that my little flock continued to thrive so much, but I seldom had a death."

Mr. Warington and Mr. Gosse commenced experiments with sea-water, almost simultaneously in the spring of 1852, and with such success as to establish the possibility of adjusting the balance of animal and vegetable life, so that the most delicate productions of the deep sea may be reared in small tanks, with scarcely any detriment to their health and vigour. Mr. Bowerbank, following in the steps of Mr. Ward, in the culture of fresh-water plants and fishes, gave to Mr. Mitchell, Secretary of the Zoological Society, the hint which resulted in the establishment of the interesting vivaria at the Regent's Park Gardens, unquestionably the most curious and novel scene which those charming gardens contain. The botanist and zoologist have here presented to them, sufficiently close for microscopic examination, those productions of nature which hitherto have been most hidden, and hence least studied of all the tribes that come within their circles of research.

New species have been distinguished, the forms of those already known are now displayed in all the freshness of life and health, the habits of the creatures in all their moods manifested even more plainly than we could expect to see them, were it possible to watch them in their native deeps; besides this we can watch the growth and reproduction of animals and plants which heretofore we have been wont to make acquaintance with as isolated, mutilated, shrivelled, and dead specimens, happy if we could detect a few of their structural peculiarities after death had contracted, distorted, or destroyed the most delicate and most interesting. But in the Aquarium

> ———The minutest fish
> Will pass the very hardest gazer's wish,
> And show his little eyes' anatomy. *Keats.*

The Aquarium-house at the Regent's Park Zoological Gardens was first opened to public inspection in 1853, and at once attracted popular attention for the novelty and rare beauty of the exhibition. From that day we may fairly date the establishment of the Aquarium as a popular adornment, either of a public exhibition or a private household. The knowledge of the principles involved in its construction and maintenance spread rapidly among students and *dilletanti;* exhibitions of a similar kind, though of less perfect character, were subsequently opened at various public institutions, and among others at the Crystal Palace; at the Surrey Gardens; the Royal Polytechnic Institutions; by the Zoological Society of Ireland, in Dublin; and by other public institutions at Edinburgh, Galway, and Scarborough; while on the continent, where studies of this kind are far less popular than here, several scientific societies kept pace with the times, and added Aquaria to the number of popular recreations and means of scientific study.

The Aquarium involves so many matters of minute detail, that its present perfection is to be attributed, not to its popularity, but to the persevering ardour of the many scientific men who have given their close attention to it, and who, through patient investigation, and repeated trials and disappointments, have achieved success, and through the medium of their several published experiences have secured for this choicest of indoor recreations, the appreciation of men of taste and scientific study everywhere. To the writings of Mr. Gosse, a naturalist who has traversed the globe, and who never wrote a line but what betrayed a Christian spirit united to a profound philosophical sagacity, we owe much of our extended knowledge of marine life, and of the rationale of Aquarium management; and to the student of the Aquarium I most heartily commend that gentleman's elegant and able works on the subject, and here cheerfully acknowledge that I am deeply indebted to them for information which I could scarcely have acquired by other means. Mr. Warington, an old disciple of this school; Mr. Bowerbank, Mr. Sowerby, Dr. Badham, and recently Dr. Lancaster, have severally thrown light upon the subject, and to these works of high character, I humbly add my own work on "Rustic Adornments for Homes of Taste," in which was offered to the public the *first* treatise on the management of the River Tank, just as Mr. Gosse's "Aquarium" was the first treatise on the Marine Tank.

THE NAME.

Whether we should call the contrivance in which living aquatic objects are presented by the term Vivary, Aquavivarium, Water Show, Aquarium, or aught else, has been settleb by a power that is not always obedient to the perceptions of the learned. Public opinion is in

favour of Aquarium, and I take it that the term has become popular because it is the most easy of utterance of any that have been devised. Dr. Lancaster's favourite designation is too long for general and familiar use, though it is perhaps philosophically the most correct. The term Vivarium, which takes the next place as suited for popular use, applies to *any* collection of animals—to a park of deer, a rabbit warren, a menagerie, or a wild beast show. Hence such a term could never convey the very special idea which we have before us in this instance. It is the *water* that gives the collection its special character; and water always reminds us of old Aquarius, who treats us to an annual drenching from his celestial watering-pot. Aquarius triumphed, and the pretty prison in which his cool companions of the sign Pisces were doomed to be confined acquired his name; and, since it is better to follow than to oppose usage, we leave the philological part of the question to the learned, and adopt *Aquarium* as the name of our collection.

CHAPTER II.

VESSELS FOR AQUARIA.



ANY vessel that will hold water without communicating to it any poisonous quality, may be quickly converted into an Aquarium. But as we desire to have at all times a clear view of the contents of the vessel, and as the admission of light is essential to the health of its occupants—though the light admitted from above into opaque vessels will be found in many cases sufficient—glass takes pre-eminence among the materials for tanks.

CONSTRUCTION OF TANKS.

The first consideration in the construction of a tank arises obviously out of the use to which it is to be put. It must be formed of materials that are not likely to communicate any pernicious qualities to the water, and hence there should be no metal-work in the interior, unless it is protected against oxidation by some harmless luting or cement. The point of next importance is to insure sufficient strength according to the capacity of the vessel; for a tank of moderate size will have to bear immense pressure laterally, as well as vertically, and the framework must be knit together with unmistakeable solidity; and the walls should be of plate glass, for, though stout common glass may last

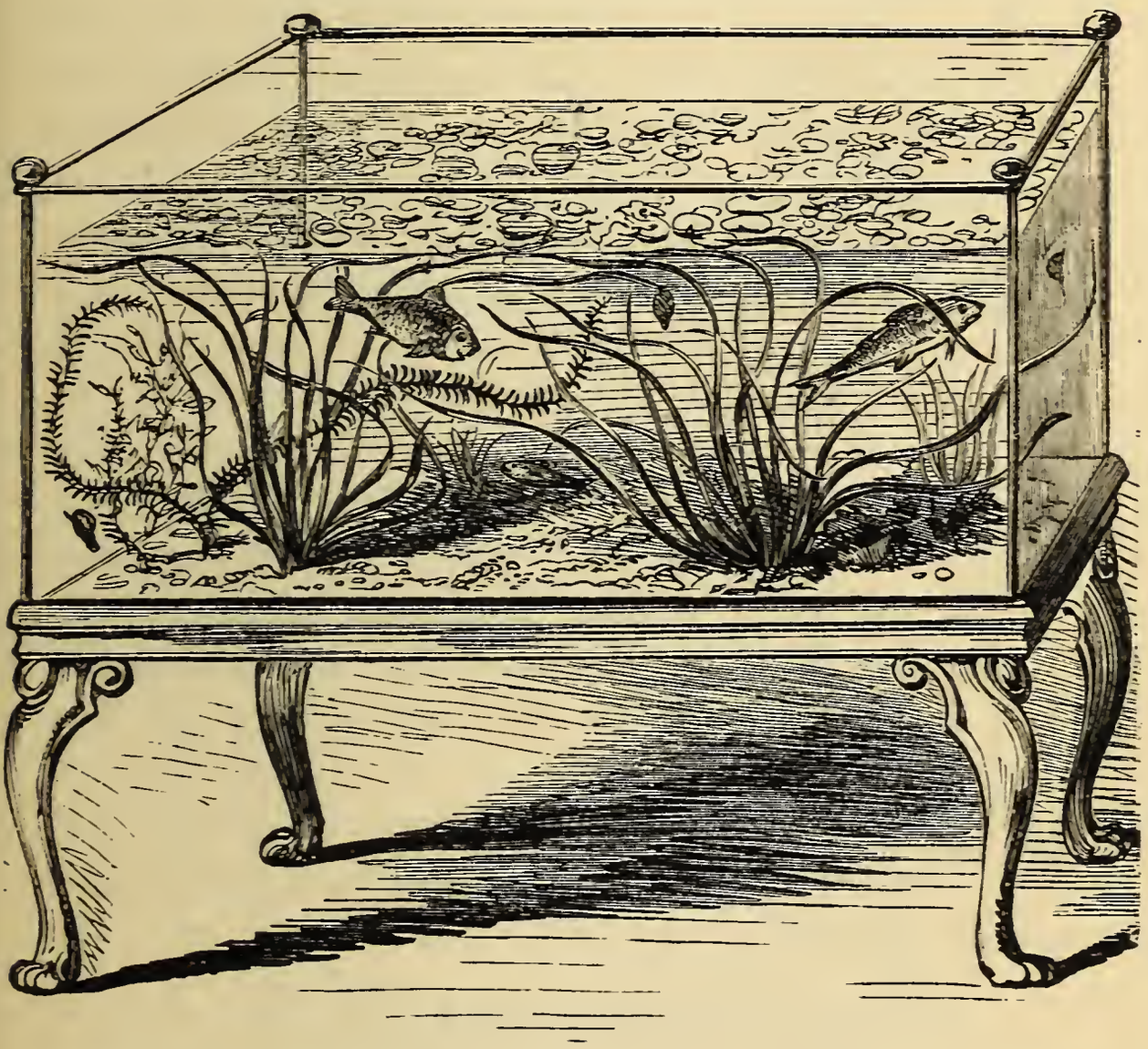
a long while, one night's frost may at last cause an explosion and the consequent loss of the stock, and great destruction of furniture. Wood, slate, and glass are the best materials for ordinary use, but iron and zinc may be employed provided the water nowhere comes into immediate contact with the metal. The glass must be fixed in grooves in the slate, and for pillars at the corners, those of turned birch wood, cut on the inner side for the reception of the glass, are the best. White-lead putty is a lasting and innocuous cement, if the tank is well seasoned before any living objects are committed to it; but a material known as "Scott's cement" is that now commonly used by the London manufacturers.

RECTANGULAR TANKS.

For elegance and general utility, a properly built vessel of rectangular outline, having at least two sides of glass, is unquestionably the best; but for special purposes a special mode of construction is adopted, as for instance, the shallow tank for crustaceans, and the slope-back tank for sea anemones. Individual taste may be exercised freely, provided the principles on which alone success can be achieved are kept in view, and the place which a tank is to occupy will often determine its size and shape.

I will describe a tank which was made for me five years ago by Messrs. Treggon, of Jewin Street, and which has been in use ever since as a river Aquarium. I consider it, as to size and make, one of the best models for a drawing-room or parlour window. It is oblong, and with all four sides of plate glass. The joints are elegantly moulded in zinc, and are very light in appearance, but strong. The base is of zinc, with bold mouldings, and it has a zinc bottom on which it

rests. Inside the bottom is of slate, and all the joints are cemented with white-lead putty, neatly painted over white; outside the metal-work is bronzed, and the top is made with a rim on three sides, so as to receive a sliding sheet of glass whenever a cover is necessary,



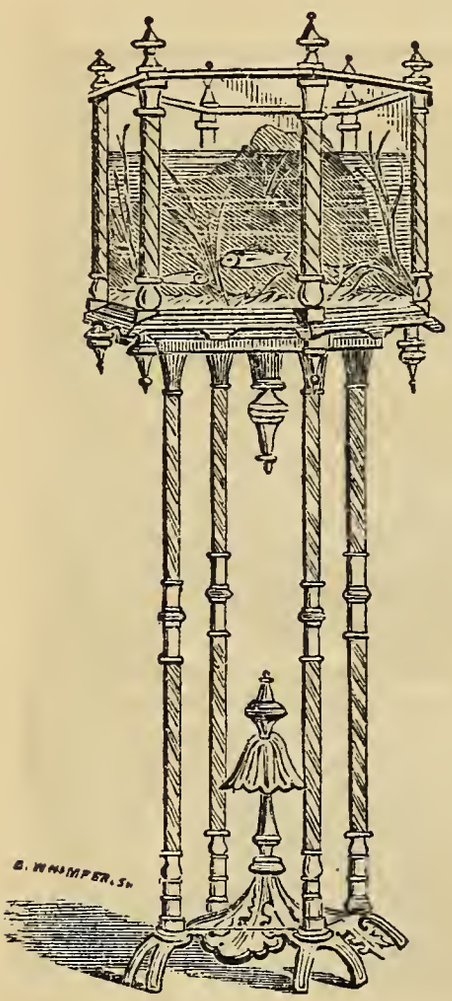
RECTANGULAR TANK,

CONTAINING VALLISNERIA SPIRALIS, ANACHARIS ALSINASTRUM—GOLD CARP, ROACH, AND MINNOW.

but which has never been used. Its measurements are from base to upper edge sixteen inches, from front to back sixteen inches, and along the front and back two feet seven inches. The cost of this was five pounds. It will be observed from the measurements given that

this tank is in length *one inch* less than it would be if a double cube. In districts where slate is not procurable stone or wood may be substituted, wood being preferable on account of its lightness.

REVOLVING TANK.

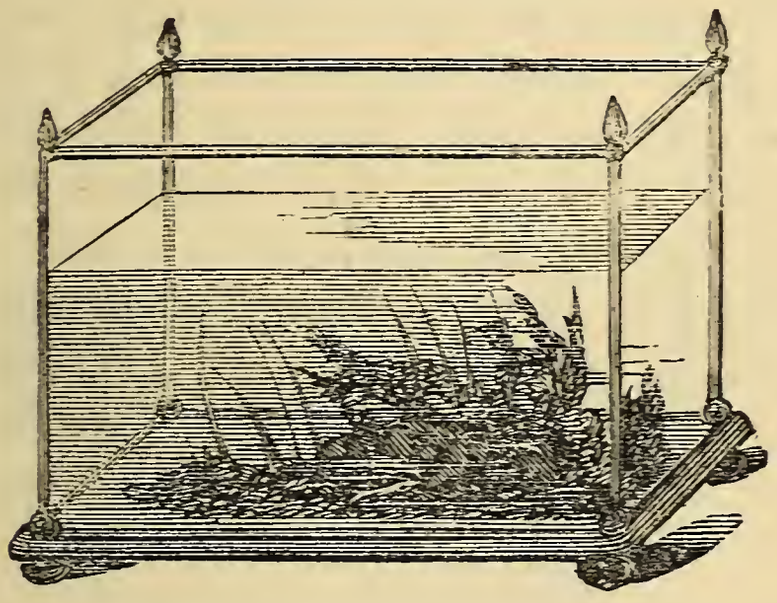


A very elegant form of tank for a drawing-room is that called the Revolving Pedestal Tank, here figured. It is made of cast iron, and mounted on a handsome pedestal, on which it turns freely for examination of its contents. It is equally suited for river or marine stock, and the side next the light is shaded with green or blue paper: it has the most elegant appearance of any of the vessels used for marine animals, and a condition under which they thrive is insured to them, because it can be moved to or from the window, according to the amount of light required.

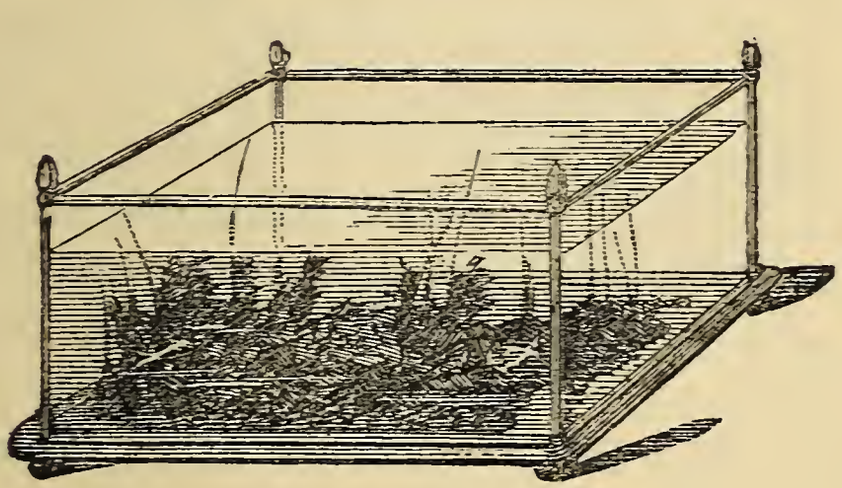
SHALLOW TANKS.

Shallow vessels are often useful for fresh-water collections, though more often required for marine. The aquarian who depends on the minute forms of vegetation only for a supply of oxygen, will find them better suited to his purpose than those that are deeper, because a pyramid of rock can be raised in the centre or round the sides with less trouble, to afford sites on which the algæ will take up positions spontaneously, and a few ornamental plants can be lowered into the places chosen

for them very conveniently. The one here figured has the following measurements:—Back and front three feet, ends one foot four inches, depth one foot six inches.



The bottom is of slate, and the four sides are all of plate glass. Four turned pillars of birch wood unite the four sides, and four similar pieces bind the whole along the top edge. A tank of this kind is supplied



by Mr. Lloyd for five guineas. A still shallower tank of the same character measures four feet by two feet, and one foot deep.

TERRA COTTA TANKS.

Mr. Gosse describes a mode of making vessels of potters' clay, or *terra cotta*, Mr. Dodgson, of Wigton,

having used such materials with success. They are simply moulded in the usual way, all of a piece, and the required size and shape; that is to say, the bottom, the two ends, and a rude arch across to brace the ends together, the front and back being left open to receive sheets of glass. After being submitted to the fire they become as hard as stone, and may be made to look as well and last as long as real masonry; but they are enormously heavy, and can only be used in pottery districts, because their carriage for any distance would make them as expensive as metal tanks made on the spot; but their first cost, even when made to hold from twenty to thirty gallons, is but a few shillings.

CYLINDRICAL VESSELS

Of various sizes and forms are used for Aquarium purposes with perfect success as to the health of the stock, but there is one great objection to them, that they distort the view by unequal refraction. The common propagating-glass used by gardeners is the simplest and cheapest vessel ever hit upon for the purpose, and their adoption places this best of domestic pleasures within reach of the poorest student, the village schoolmaster, and the inquiring youth may, by the help of such vessels, share with the wealthiest in studies that are profitable to all. It is rather curious that while Dr. Badham and Mr. Gosse were giving manufacturers perplexing orders for blown tanks, which cost from fifteen to twenty shillings each, a better kind of vessel was to be found in every horticultural glass warehouse, needing only to be turned upside down to bring the difficulty to an end in a moment.

Mr. Hall, an experienced naturalist, now employed at the Medical School, St. Thomas's Hospital, was the first

who conceived the happy thought of turning a propagator upside down to extemporize an Aquarium; and the first Aquarium of this form was exhibited in his window, mounted on a deal box, with a hole cut in the centre to receive the knob of the bell. That simple trick of creating a cheap and elegant tank did more to popularize the Aquarium than all the exhibitions and all the books that have been written on the subject,



for it enabled thousands to enjoy a delight which had previously been confined to the wealthy few. Messrs. Phillips, of 180, Bishopsgate Street Without, have at my suggestion produced vessels of this kind, of an improved shape, and of a quality of glass less liable to fracture than was previously used. Turned stands to receive these vessels are to be had at the glass shops

at very moderate prices, in fact a few shillings will provide both glass and stand.

Another and most elegant kind of cylindrical vessel may be formed by inverting a French shade, such as is used to cover alabaster ornaments. If fitted into a polished wood frame, so constructed as to partially grasp the sides of the vessel, and with a hollowed foot in which the base may rest, a clear view of the interior may be obtained, and minute specimens of animal and vegetable life, whether marine or fluviatile, kept to advantage. Into the turned stand which receives the base of the vessel two uprights should be fixed, and from each of these a semicircular piece of wood should proceed, each of them fitting partially round the vessel, and thus grasping it, and preserving it in an upright position, while the chief weight is borne by the turned stand. Or, if such a vessel were required on a larger scale, a fern shade might be inverted, and set into a hollow on a turned stand, or even placed in the glass dish in which ferns are usually grown, the dish being first filled with moss or some yielding material, to keep the tank steady, and prevent fracture from the meeting of two unyielding surfaces.

Lastly, an earthenware foot-bath forms a cheap and serviceable Aquarium, especially for marine objects; glass milk-pans do well for zoophytes and all descriptions of ground stock; while for madrepores, the smaller *Actiniæ*, tube worms, and for larvæ and fresh-water insects generally, small jars of flint glass are the best of vessels, because in such the *balance* of animal and vegetable life may be adjusted to perfection, and the study of the minuter kinds of aquatic life is through the portableness of the vessels greatly facilitated.

The student should possess a variety of vessels, in order to keep certain classes of subjects apart from the

general gathering. Tall cylindrical jars are very useful for *Vallisneria* and microscopic objects, and small bell-glasses serve as nurseries, into which to consign the odds and ends of a day's work by the brook or river side. Indeed as adjuncts to high-class tanks, such vessels have special uses of their own. Still the tank, whether rectangular or vase-shaped, is a distinct thing in itself. The beauty is to be found in its completeness and the extent afforded for a variety of objects; and when we speak of an Aquarium, we mean a vessel holding from six to thirty or more gallons of water, formed partially or wholly of glass, and stocked with plants and fishes in a living and healthy state. A cover is not essential, but where there is much dust it is advisable to use a sheet of glass, and to prevent the escape of reptiles a lid of wire gauze may be adopted.

CHAPTER III.

THE PHILOSOPHY OF THE AQUARIUM.



THE mere assignment of a few fishes, sea anemones, plants, or other gatherings of aquatic life to a vessel of water does not constitute an Aquarium. The term implies a self-sustaining collection, so adapted that the balance of forces which is maintained in the scheme of nature shall have its counterpart on a smaller scale. There can be no success, no pleasure, and but little instruction in the keeping together of a heterogenous assemblage by merely artificial means. The vessel may be furnished with a fountain and waste pipe, so as to keep up a constant change of water, and will then support a vast number of fishes without distressing them; or the water may be frequently drawn off by a siphon, and its place supplied with fresh for the same purpose, and such methods are admissible where the Aquarium is used for decorative purposes only. But it is an essential principle of the Aquarium, scientifically considered, that the water shall never be changed, and that no artificial means whatever shall be used to keep up the supply of life-giving oxygen for the support of its animated inmates. By "never changed" I mean that the balance shall be so perfectly established between the reciprocating actions of animal and vegetable life, that the changing of the water becomes a matter of convenience, and not of neces-

sity; it may be changed perhaps once a year, for the purpose of re-arranging the furniture, or laying down a bed of fresh clean pebbles, but not at all for the purpose of promoting the health of the creatures.

THE BALANCE.

What happens when we put half a dozen gold fish into a globe? The fishes gulp in water and expel it at the gills. As it passes through the gills, whatever free oxygen the water contains is absorded, and carbonic acid given in its place; and in course of time the free oxygen of the water is exhausted, the water becomes stale, and at last poisonous, from excess of carbonic acid. If the water is not changed the fishes come to the surface and gulp atmospheric air. But, though they naturally *breathe air as we do*, yet they are formed to extract it from the water; and when compelled to take air from the surface, the gills, or lungs, soon get inflamed, and death at last puts an end to their sufferings.

Now if a gold fish globe be not overcrowded with fishes, we have only to throw in a goodly handful of some water weed, such as the *Callitriche*, for instance —and a new set of chemical operations commences at once, and it becomes unnecessary to change the water. The reason of this is easily explained. Plants absorb oxygen as animals do; but they also absorb carbonic acid, and from the carbonic acid thus absorbed, they remove the pure carbon, and convert it into vegetable tissue, giving out the free oxygen either to the water or the air, as the case may be. Hence, in a vessel containing water plants in a state of healthy growth, the plants exhale more oxygen than they absorb, and thus replace that which the fishes require for maintaining healthy respiration. Any one who will observe the

healthy plants in an Aquarium, when the sun shines through the tank, will see the leaves studded with bright beads, some of them sending up continuous streams of minute bubbles. These beads and bubbles are pure oxygen, which the plants distil from the water itself, in order to obtain its hydrogen, and from carbonic acid in order to obtain its carbon.

INFLUENCE OF VEGETATION.

The presence of vegetation then is a matter of necessity. The Aquarium is not only a vivarium but a water garden, in which we make intimate acquaintance with plants and animals of kinds hitherto least studied by naturalists, and obtain new readings in natural theology from a region but newly revealed to us, having before us lessons of the workings of Almighty Wisdom in "the waters under the earth." The balance must be maintained by the assortment together of due proportions of animal and vegetable life, and hence it is that botany and zoology are equally favoured by the enterprise.

But here is the first stumbling-block to be encountered by the student. He has furnished his vessel with chosen plants from the brook and river side, and in the course of time nature sets to work in opposition to his scheme by introducing an order of vegetation he is by no means disposed to welcome. The horrible green slime appears on the pebbles, the rock-work, and the glass. He cleans it off, but it will re-appear in spite of him, and meanwhile the chosen plants acquire a more delicate green hue than is natural to them, and while they improve in beauty, they are hastening to decay. Thus there is a perpetual necessity for renewal of pond-weed, and starwort, and water-soldier, etc., etc., a perpetual scrubbing of the glass and the rock-work, to keep down the spon-

taneous growth. But examine that growth with the microscope, and forthwith you have before you a race of plants so varied in character, so beautiful in detail, so abundant and so luxuriant in growth, that you turn microscopist, and forget the every-day wonders of the tank in the passion of exploring what was a short time since denounced as a nuisance. The amateur is not alone in abjuring the spontaneous growths of the tank. Dr. Badham, in his memorable essay in "Frazer," dealt with them as vegetable vermin. Dr. Lancaster, in the "Aqua-vivarium," says "they are its weeds, its pests, and will sorely trouble the amateur."

I have long been convinced, as the result of experiment and observation, that so long as these microscopic algæ are regarded as pests, Aquarium studies will make but slow progress. Are we to follow nature or attempt to coerce her? Follow her, I say; and as she sends those yoke-threads and quiverworts into the Aquarium by millions, let us believe they come for a good purpose, and all will be well. But the admission gives a new turn to management, as it opens a new chapter in Philosophy, and we must briefly consider the two subjects together.

In my contributions to "Recreative Science," I have laid down this rule for managing aquaria:—Stock them properly, and LEAVE THEM ALONE. Instead of fighting against confervoids let them flourish; instead of trusting to phenogamous vegetation, that is true flowering plants, trust to the plants which stud the rock-work and the glass sides in the form of a microscopic forest, and the supply of oxygen will be unceasing and abundant. By this plan you get rid of a foolish prejudice against "green slime," for in truth its appearance as a green coating, and without regard to the microscope, is pleasing; it prevents an excess of light, which is injurious, gives

a pleasing hue to the water by the passage of the light through it, and insures to the fishes those natural conditions of existence, wanting which an Aquarium is but a watery prison, in which they pine and perish. To preserve a clear view of the collection, the front glass must be kept clean by the use of a sponge attached to a stick, or a wash-leather on which is smeared a little fine silver-sand; but on the back and sides, and wherever else the microscopic plants cast anchor, there let them be, and the affair will prosper to your heart's content. Even then the ornamental plants which have hitherto been considered the only proper vegetable inmates, may be used, but for purposes of decoration only, to be removed and renewed as the seasons change, or occasion may require. Thus one important point is cleared up, the Balance can be insured only by a reasonable encouragement of spontaneous vegetable growths.

INFUSORIA.

There is one more feature of importance—when a tank is properly stocked, the water soon gets crowded with infusorial animalculæ, which swarm among the plants, and on the sides of the glass in countless thousands, visible only by the aid of the microscope. These are in accordance with a natural law; the presence of vegetable matter in water always induces them. But observe their value: they contribute to the sustenance of the smaller fishes, by supplying them with food; and, strangely enough, the researches of modern chemists have proved that these minute creatures respire in much the same way as plants. While all other animals absorb oxygen, and perish if the supply of that gas is withdrawn, these minute organisms absorb carbonic acid, *and give out oxygen in abundance.* This has been proved by Professor

Leibig, who collected several jars of oxygen from tanks containing infusoria only. Every one who has had experience in the management of tanks must have noticed that the water in a tank, which has been established some months, will sustain a much greater amount of animal life than one of the same dimensions but recently stocked. The presence of infusoria in immense numbers is *one* of the reasons for this.

So far I have endeavoured to explain the theory of the Aquarium, in the merest outline. Still, brief as this chapter must be, I must here impress upon the mind of the beginner, that unless the leading features of the theory are borne in mind, success can never be achieved in the establishment of water collections of any kind.

If a tank requires frequent cleansing, or frequent changing of water, if the fishes come to the surface for air, or perish through the presence in the water of offensive matter—in fact, if the whole affair has not a distinctly self-supporting character, such as will preserve its purity, and strength, and beauty, without alteration of any kind—it must be concluded that it has been either unskilfully stocked or injudicially managed.

It is my object to explain briefly, but clearly, the whole *rationale* of Aquarium management, whether the tank be adopted as a mere ornament—than which there is nothing more beautiful—or as a museum of instruction and a school of study—than which there is nothing more suggestive, nothing that can afford finer lessons of the subtlety of the forces, or the refinement of the instincts, that give life and loneliness to the "world of waters."

CHAPTER IV.

FURNISHING.



I SHALL endeavour under this head to give instructions adapted to the established method of management, as well as to the method described in the last chapter. I will not seek to confine the reader to a plan which he is at perfect liberty to think unphilosophical.

ROCK-WORK.

It matters little how much or how little rock-work may be used, so far as the health of the collection is concerned, provided the materials used are perfectly innocuous. Rocks that contain metallic substances are of course objectionable, as likely to poison the water, but any ordinary kinds of sandstone, limestone, or granite may be used, according to the taste of the cultivator, or the nature of the design to be carried out. Rock-work is by no means essential: some of the best managed tanks within my range of experience are wholly without it, and the bare appearance the tank would

have if cryptogamous vegetation only was encouraged for the supply of oxygen, was avoided by the plentiful use of that beautiful plant, *Vallisneria spiralis*, which, contrary to the rule which prevails with most high-class plants, invariably thrives in the confined area of an Aquarium. It must be remembered that the more rock-work the less water, and, *pari passu*, the fewer fishes, for the capacity of the tank is bounded by its sides, and every cubical foot of rock occupies the room of a cubical foot of water.

There are many modes of constructing rock-work. When it is intended to form a rustic arch or grotto, the best plan is to use Portland cement, which must be mixed first into a thick paste with water, a small quantity at a time, and moulded into the required form, and, as a rule, the rougher it is the better will be its appearance. It is best to mould the work in a wooden box of the same size as the Aquarium to prevent accidents, and as the cement will not adhere to glass, the arch should be constructed in a separate mass, so as to allow of lifting it out whenever any change of furniture is determined on. If the sides of the Aquarium are of slate the arch may be moulded to it as a fixture, but it is far preferable to have it in a portable form. But the Portland is enormously heavy, and unless the tank is a very strong one, a cemented rockery may be too much for it. To obviate this, rockwork is sometimes constructed of gutta-percha, which I believe answers well, and takes colour readily, but I can give no opinion as to its merits from my own experience, never having had occasion for its use. If real stone is preferred pieces of sandstone may be cemented together by means of Portland, into any suitable form, or a few rough slabs may be built up into the form of a cromlech, and if the topmost stone is just below the

surface of the water, a pan of *Lycopodium denticulatum*, with a water-loving fern in the centre, may be placed upon it, and will give an additional charm. The pot itself may be imbedded in a rough coating of cement, or with small pieces of "burrs" cemented together, so as to hide the nature of the contrivance.

On this plan I fitted a tank three years ago, and it proved so ornamental in its arrangement, that it was allowed to remain so till lately as a decoration for the entrance hall. But the best of all rock-work, because of its lightness and facility of construction, is formed of common coke. Select the pieces according to size and shape. Dip them two or three times in a thin batter of Portland, and then build them up as you please with cement, and if an arch or grotto is required make it in two or three parts, to fit together in the tank, so that the whole can be removed at any moment, and replaced, if required, as originally formed. If the tank is to be managed on the principle of natural compensation, "pockets" may be formed in suitable places to receive flower-pots containing ornamental plants, as will be fully explained presently.

THE BOTTOM.

The best bottom is formed of well-washed river-sand or small pebbles, or river-side grit. A bed of sand covered with pebbles is perhaps the best, but pebbles alone answer very well, and if at any time they get black from the deposit that is always accumulating, take them out and lay them in the open air for a week, in full daylight, and their natural colour will be restored. A store of grit put aside for a change is useful but by no means essential. I find that once a year is quite often enough for works of renovation.

Mould has been extensively recommended as a bottom for tanks. I used it myself till I became convinced that it could be dispensed with altogether. It necessitates frequent changing of the water for at least a fortnight after the first stocking of the tank, in order to get rid of the soluble vegetable matter, which the water dissolves out of it, and the fishes take delight in stirring it up, so that the vessel is too often in a state of opacity by the diffusion of mud, and nothing can be seen. I now use sand and pebbles only, and I find that aquatic plants of all kinds root freely and flourish in it, and, indeed, if pebbles only be used, they flourish just as well as if their roots are covered.

PLANTING.

On the old-fashioned plan the next step is to insert the plants, the arrangement of which will depend on the shape and size of the vessel. Generally speaking, massive plants look best if set back with lighter plants before them, just the same as a painter sets his chestnuts and elms in mid-distance, and his lady birches in the foreground. *Stratiotes*, *Potamogeton*, and other plants of a massive and decided character, are well seen through the interstices of *Myriophyllum*, *Callitriche*, and such like fragile and delicate structures. The flowering rush makes a fine centre piece for a vase, and appears to good advantage when seen through an archway, in a tank containing rock-work.

If there is a bed of two or three inches of sand, the roots may be gently pressed down into it, and a few clean pebbles laid over the spot to keep the plant in its position. Some plants will require a stone to be attached to them by means of a thread to fix them properly. Crowns of *Stratiotes* that have not formed roots, may be planted in this way. First cut away any

black or decaying matter from the stem, and pull off any discoloured leaves, taking care not to injure the centre, then pass a piece of bass round the base, and attach a small stone. The plant will remain firmly where placed, and will throw out roots, and fix itself before the rotting of the bass takes place. It will then throw up new crowns and become a very ornamental object. Loose stems of *Chara*, *Anacharis alsinastrum*, or *Callitriche*, may be gathered together, fixed by means of a stone in the same way. They will generally get well rooted in a fortnight, and remain firmly where planted.

All the river plants that root or form buds at joints on the stem, such as *Potamogeton*, *Anacharis*, *Callitriche*, *Ranunculus*, *Myriophyllum*, *Chara*, *etc.*, do as well without roots as with them. You have only to take a tuft, or even a few sprays, tie their ends together with a strip of bass, and attach a stone to keep them down. Then, holding the tuft in the left hand, lower it into its place, and pile a handful of pebbles to fix it; and so on till you have planted the vessel to your liking. Then shower in the shingle to make a regular bed. Plants that do not form joints, such as *Butomus*, *Nymphæe*, *Alisma*, *etc.*, must have their fibrous roots spread out on the slate or glass bottom, and covered with a few inches of pebbles in the same way; and when all are planted, water them all with a large fine rose of a watering-pot, till the water is a few inches deep in the vessel; after which you may pour it in without the rose without fear of washing any of them out of place.

THE NATURAL SYSTEM OF TANK MANAGEMENT.

So far so good. Let us now consider the better method of getting oxygen in the way Nature prefers to

supply it to the vessel, which is the way also to put an end to the enmity that has so long subsisted between the aquarian and the microscopic vegetation. If tanks are to be managed on the self-supporting principle, away with the flowering rushes and water violets, water milfoil, and all the tribe of *Nymphæa*, and trust for the supply of oxygen to the spontaneously produced vegetation, of which there will be plenty, if the foolish system of scrubbing and cleaning, and changing the water be given up. The majority of aquatic plants enjoy but a temporary prosperity. After awhile they rot at the base, and float away from their moorings, or get so sickly for want of deep soil to root in, and hot sunshine to stimulate their growth, as to be a nuisance. Exceptions may be made in favour of *Vallisneria spiralis*, the best of all Aquarium plants; *Anacharis alsinastrum*, which will thrive under the most trying of circumstances; *Stratiotes aloides*, which floats about, grows well in a subdued light, and occasionally anchors itself by means of its long cord-like roots; *Hydrocharis morsus-ranæ*, which floats on the surface, and does well in most positions; and the three *Lemnas, minor, trisulca*, and *polyrhiza*. Any of these may be permanently planted, and it will be very exceptional indeed if they do not prosper, especially if there are no *Lymnea*, which are very destructive. With the exception of these, trust to the *Confervæ*, the *Oscillatorieæ*, *Vaucheria ungeri*, and other low forms of vegetation, which come in their own way in every tank which is left undisturbed, and there will be plenty of surface for them to rejoice upon if only the front plate be kept clean, by means of a sponge attached to a stick.

This proscription of the very plants which have been considered the most attractive features of the Aquarium may create surprise. Let not the surprise be changed

to fear; you may have them all, and many other beautiful aquatics, if you take care not to plant them. I use a very large variety of British and exotic plants as tank decorations, and amongst the number of my favourites are ferns. The subjoined illustration represents a tank fitted expressly as a water fernery, and it accomplishes all that can be desired as a decorative object without violating any principle of Aquarium philosophy. Instead of planting in the Aquarium, pot plants only are used. They are grown expressly for the purpose, and may be changed as often as the extent of the stock of plants will allow, so as to vary the scene with the changes of the seasons.

TANK DECORATION.

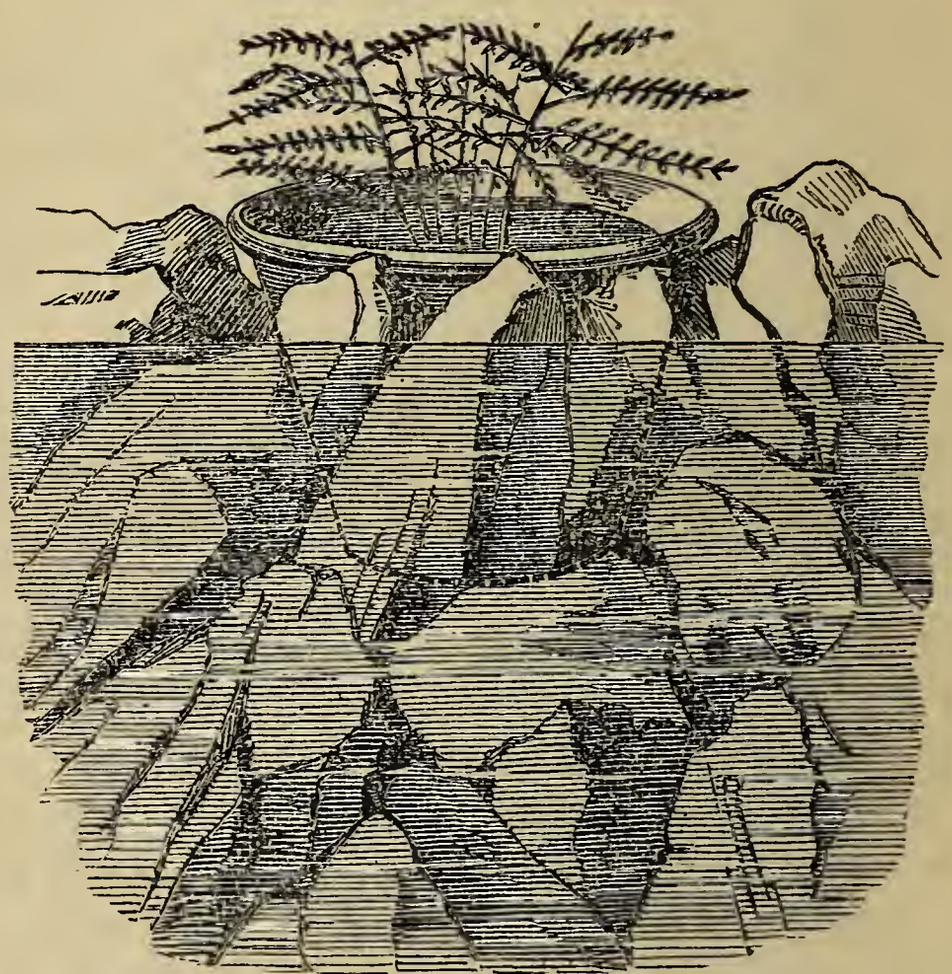
To carry out this scheme all that is necessary is to model a rockery to the shape of the tank. Use pumice-stone or coke, in the way just described, and you will secure the desideratum of a substantial and handsome rockery, weighing only a few pounds instead of two or three hundred-weight. In the tank which forms the subject of illustration the rock-work consists of a series of arches, bearing eight summits, to correspond with the eight sides of the vessel, the whole resting on four shafts from which the arches spring. The eight summits and the centre are hollow, that is, to use gardeners' language they have "pockets" of the proper width and depth to receive flower-pots of what are known as 48's, the size most used, and in which very large specimen plants may be grown.

By this plan you accomplish two objects; you conform to the best principles of Aquarium management, by keeping out of the tank all such plants as are unsuitable, and you indulge your ferns with a course of treatment which suits a certain number best of any.



Fernery Aquarium.

I was at an expense of some pounds last spring to make a tank with supply from the New River, and siphon pipe to keep the water to a proper level, expressly to grow two of our commonest ferns, *Osmunda regalis* and *Athyrium filix-fœmina*. They are in nine-inch pots, plunged six inches deep, and have become magnificent specimens, well worthy of the trouble bestowed



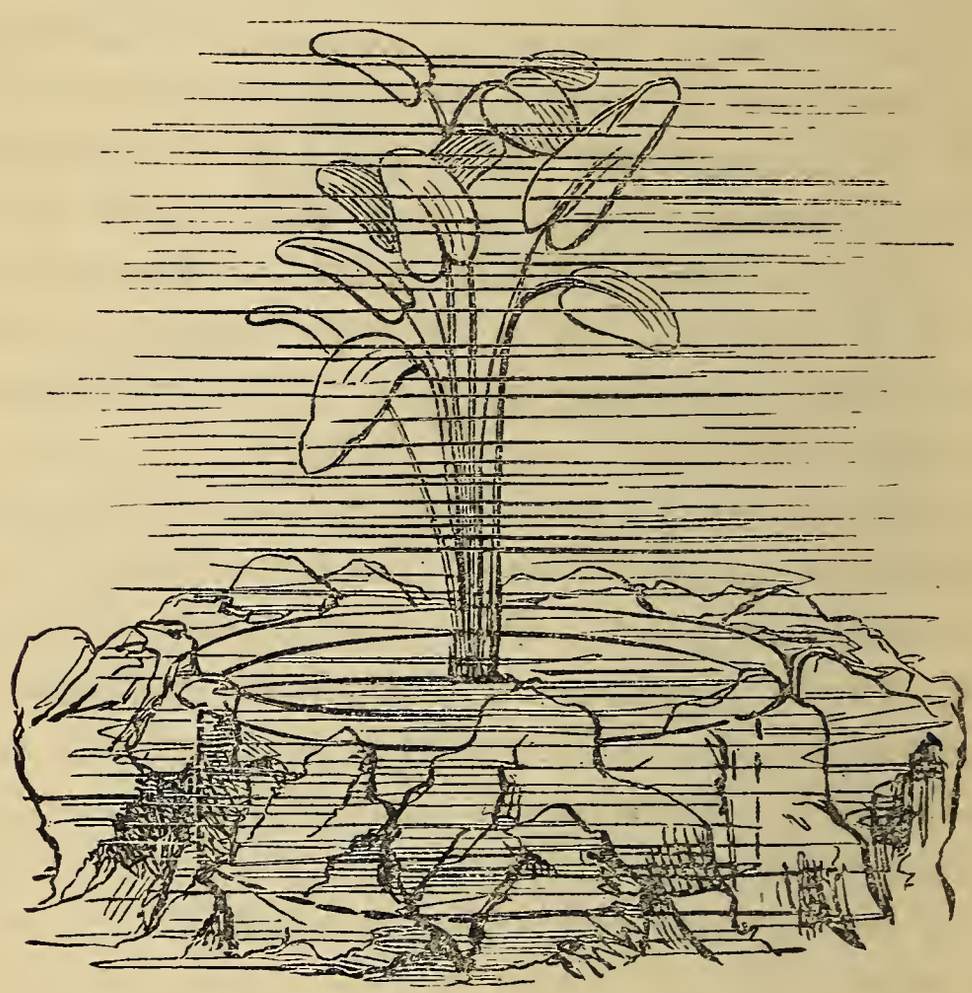
Flower-pot encased in Rock-work, *partly* plunged in Water, for Ferns.

upon them. Yet, the royal fern is one of the very worst for pot-culture under ordinary management. In the mode of managing tanks, which I am now advocating, the ferns need only to be properly chosen, and their growth will be marvellously perfect and luxuriant, provided the bottoms of the pots only touch the surface of the water, or are plunged in it not more than two

or three inches. When their season is over, their removal is a simple affair of lifting out the pot, which is easily replaced with another, and so on *ad infinitum*. The lovely *Cystopteris fragilis*, planted in one of Pascall's shallow cutting-pots, surfaced round with *Lycopodium denticulatum*, makes a beautiful ornament on the summit of a cromlech in one of my tanks. It is usually two inches deep in the water; it grows with vigour and delicacy, throws up numbers of new crowns, and is much more persistent than under any other method of management. If it casts its fronds early, I cut them close over, and a new crop starts at once; but it rarely shows a brown frond all the season, its habit is so changed by this truly aquatic mode of culture, which is favoured by those convenient conditions, shelter and shade.

The ferns so used in the tank before represented are: *Scolopendrium angustifolium*, *Onoclea sensibilis*, *Asplenium adiantum-nigrum*, *Osmunda gracilis*, *Platyloma falcata*, *Pteris serrulata*, *Polystichum coriaceum*, and *Cyrtomium falcatum*. The last four are in front, and are drawn in detail. The centre is occupied with the *Athyrium filix-fœmina*, the true Lady Fern. There are at least a hundred fern species and varieties which might be used in the same way, and which, when so used, could be preserved during winter in a cold frame, and require but the most ordinary care in cultivation. If we admitted flowering plants, as we certainly ought, the names of those suitable are legion. The pretty blue-flowered *Sisyrinchium anceps* is a first-rate thing for plunging in the pockets, and with a set of these all round and a fine Calla in the centre, you would have a glorious garden of water-flowers without getting involved in a single one of the many meshes that beset ill-advised experiments with the Aquarium. True aquatics, such

as water-lilies, water-milfoil, starwort, potamogeton, sweet-rush, water-plantain, marsh marigold, water-cress, and others, which it would be ruin to a tank to plant in it, might be grown in pots ready cased in blocks of rock-work and plunged in a stone trough, cistern, or fishpond, and during their flowering season lifted out and lowered into the Aquarium, to adorn it for a time,



Flower-pot (flat shape, as in sketch) encased in Rock-work, *wholly* plunged in water, for Lilies.

and then be removed back to their original quarters. Those who have my "Rustic Adornments" will find, at pages 131 and 401, lists of plants in varieties sufficient to keep almost any number of tanks gay the whole year round, and the mode of using them here recommended offers the additional advantage that you have not to plant and wait for the result, and then perhaps

be disappointed, but the result is ascertained at once; if one of a set of plants is too dwarf, too coarse, or otherwise unfit to range with the rest, another can be substituted, and thus you secure ferns and flowers apparently growing *in situ*, with the simplicity of arranging a few specimens on an ordinary flower-stand.

The water should be pure and bright when introduced to the tank, and if the supply is at all faulty, it will be best to pass it through a filter before using it. Spring-water will do very well, but must stand a day or two to allow the plants to soften it, before the fishes are put in. My tanks are all filled with spring-water, which I find altogether unobjectionable; but for the marine tank I think it preferable to any other in the manufacture of artificial sea-water. Writers on the Aquarium usually insist on the use of river water, but in many places this is not attainable, and it is satisfactory to know that artesian, or well water will serve the purpose admirably. The best way to fill a tank is by means of a fine rose of a water-pot.

CHAPTER V.

STOCKING AND GENERAL MANAGEMENT.



ROM the very first the aquarian must keep in remembrance the nature of the forces he has invoked by the establishment of the Aquarium. My own views have changed considerably as year after year has added to my experience; and though one consequence of continued observation is the conviction that tank management must be pursued in a precise and methodical manner—for haphazard ways only lead to trouble—on the other hand the precise and methodical manner may be stated without much difficulty. The first step to success is to insure a proper

ASPECT.

I openly unsay my former recommendation to place the fresh-water tank within reach of the sunshine. While holding to the alismas, and crowfoots, and flowering rushes, there was a necessity for abundance of light, because those plants grow in places exposed to the full glare of a summer's sun, and soon perish if the vivifying rays are excluded from them in the tank. But while we are exposing the vessel in a south aspect to an intense amount of daylight, for the sake of the plants, we are deranging all its other elements, and insuring a muddy opacity by the production of an excess of floating vege-

tation, and by the increased temperature of the water, most surely inviting death to visit its finny tenants.

When I had fully made up my mind that the higher class of plants could be used only as temporary adornments, I saw the possibility of reducing the amount of light; then the occasional conversion of the water into soup was at an end, and death kept at a distance from my piscine family.

In recommending a north aspect and a very subdued light for the Aquarium, whether fresh-water or marine, I find myself borne out by Mr. Lloyd, who, in his admirable "List of Objects for the Aquarium," lays stress upon the injunction against admitting lateral rays as a reversal of the course of nature. It is obvious that in any naturally situated piece of water, as a lake or river, the light enters the fluid vertically, and as a natural lake has not transparent sides, why should we attempt to change the order of things by admitting light to the tank from all sides as well as from above? For the due development of the microscopic vegetation, and for the health of *Anacharis*, *Vallisneria*, *Hydrocharis*, and the *Lemnas*, which are the best of permanent plants, a moderate amount of vertical daylight, is quite sufficient. As every one of my windows is supplied with aquaria, fern-cases, etc., etc., I have for convenience sake removed jars of *Vallisneria* and small collections of water-plants and insects to some distance from the light, and instead of seeing them perish, they continue to thrive, and though confervæ are produced as I could wish, there is no turbidity, but, on the contrary, a sufficient space of glass is easily kept bright for observation, and the water is as transparent as if just brought from the spring, Nevertheless the fresh-water vessel will bear more light than the marine, and where a tank of each kind is to be kept in the same window, the fresh-water vessel

may be placed next the glass, and the marine tank before that, and at a lower level. Now supposing the river tank to have four sides of glass, the plan I have proposed of building a rockery may be made to shut out the light from the side next the window, and if the conferva is allowed to grow unchecked on the two sides, they become soon opaque, and the front is left to us for a peep-show. Mr. Lloyd, who has given more minute attention to the proper construction of tanks than any other person living, makes very few vessels wholly of glass, preferring to use slate for the ends, and sometimes for the back, when the purchaser purposes to place the vessel in a south or east window. But as other makers persist in using too much glass, and as the majority of beginners think there cannot be too much light thrown on the subaqueous kingdom, I feel the necessity of considering this part of the subject as it applies to the tanks in common use. We can darken glass, but we cannot make slate transparent, and hence a tank formed wholly of glass can be adapted to any situation. Therefore let it be understood that a full flood of daylight is more harm than good, a frequency of sunshine destructive, and that the tenants of an Aquarium are seen to better advantage in a vessel lighted from above only.

It follows from this that a conservatory is a most improper place for an Aquarium, and as a correlative it is a fact that with the exception of collections of gold-fish, which can endure a heat of 80° without injury, aquaria in conservatories generally cause an infinity of trouble, and end at last in utter disappointment. As the conservatory or greenhouse is unsuitable, so is a south exposure, because of excessive heat. If a run of water is kept up in a tank, fishes will thrive in almost any position, because they are in no danger of being boiled by a July sun, but in an Aquarium proper, which has no

change of water, an equable temperature is most essential. Cold is far less injurious than heat; indeed I have many a time had eels and minnows frozen up, and unable to extricate themselves, and no losses happened.

During the past February, (1860,) my experimental tank, of thirty gallons capacity, now in its fourth year without change of water, or the presence of a single scrap of introduced vegetation, was frozen all round to the thickness of four inches; the fishes merely became a little torpid, and kept together at the bottom till the thaw came, and not one of them was injured. I could not recommend the exposure of a tank to frost any more than I recommend its exposure to excessive light and heat, for if the fishes endure it with patience, the vessel may not, and the thaw may reveal the unpleasant fact that the tank leaks through the strains subjected to, and the chances are that it may never be restored to soundness.

In stocking a tank the most important point is to proportion the amount of animal life to the capacity of the vessel. Better too few than too many fishes. Perhaps one fish to a gallon in a tank abundantly covered with confervæ, may be a safe rule, but the rule must be taken to apply only to small fishes. As comparative terms are apt to mislead, let me be understood to mean by small fishes, such as minnows and sticklebacks, or gold-fishes of not more than four inches in length. I have specimens of tench, eels, chub, and carp of six and eight inches long, but they enjoy large vessels, and are not robbed of oxygen by association with a multitude of smaller creatures. A single large specimen of pike, bream, perch, or tench may be kept in a vessel of ten or twelve gallons capacity as a pet, and with it there should be but two or three smaller fishes, which may from time to time disappear, but large specimens are altogether unsuited to mixed collections. As the question of proportion

cannot be definitely stated, let the aquarian discover it for himself, by the very simple process of stocking moderately in the first instance, and as the tank gets ripe and established, one or two additions may be made from time to time, and the affair be watched to see that there is no distress manifested. When fishes come to the surface, and suck in atmospheric air greedily, retiring below only when frightened, you may be sure you have overdone it, and must either reduce the number or submit to the cruel alternative of allowing the weakest to perish. Those you most prize may die first, and therefore prevention had better be resorted to where cure is impossible.

Very many failures have arisen from the association together of creatures that have been at enmity from the very day of their first creation. When the "Aquarium mania" broke out, it was common enough to see tanks containing fishes, reptiles, insects, blocks of coral, nameless structures coloured with red sealing-wax, with perhaps a model of a frigate on the top, "becalmed and lifeless." If the frigate kept its ports closed, there was a brisk naval warfare going on below; gold fishes had their flesh gnawed away by carnivorous larvæ, lizards got out and crept under ladies' dresses to be trodden on; and sometimes a huge beetle would take wing, and go round the room and through the flame of the candle with a horrible buzz, which from that moment brought the Aquarium into disrepute, at least with the gentler members of the family. A definite plan of association must be adopted: insects should be kept in separate jars, reptiles in vessels furnished with rockeries elevated above the water, and with wire-gauze coverings, and the "domestic amenity," that is the Aquarium fitted for general amusement, should be given up to ferns and fishes.

Among the mollusks there are many that are far too

ornamental to be shut out, as, for instance, *Paludina vivipara*, and all the aquatic species of *Planorbis*, not forgetting also the swan mussel, the duck mussel, *Cyclas corneum*, and *Dreissina polymorpha*. But as these were originally introduced to eat away confervoid growths, and as their young always get devoured by the fishes, it is best to preserve them in collections by themselves, especially if the tank is to be managed on the natural system of allowing confervæ free scope for development.

In selecting mollusks be cautious not to introduce any of the *Lymnea* too freely into a tank containing *Vallisneria*, for these gluttons make terrible havoc among its palatable foliage, and as to frog-bit, water-soldier, and *Potamogetons*, a very few of any of the species of *Lymnea* will soon clear the tank of all these plants, but *Anacharis* is rarely injured by them.

SANITORY COMMISSION.

The absence of all soil by the use of pebbles only, the absence of large plants as permanent occupants, and the encouragement given to microscopic vegetation on the back, sides, and bottom of the vessel, will be found quite consistent with a continuous and uninterrupted view of the interior, for there will be very little growth on the front glass. Thus the natural system leaves little for the sanitary commission to do, and that little consists in occasionally scrubbing the inside of the front glass with a



sponge attached to a stick. A clean straight hazel rod is what I use, and the sponge is attached by binding twine around it very firmly. The operation will make the water cloudy for a few minutes, especially if the growth

has been allowed to increase beyond the merest film, but the brightness of the fluid will be quickly restored. I must here repeat that the front glass only should be kept free of microscopic growths.

When a tank has stood twelve months or more, the water not having been changed at all during the whole time, it may be necessary to turn out the contents and re-stock it. This is not to be done unless the bottom has become black, and the roots of the plants shew signs of decay, in fact, not unless it really wants it, and if bottomed with mould it certainly will, and it must be done accordingly. The live stock should be removed by means of a hand-net, the water drawn off by means of a siphon of glass, or gutta-percha, and the plants taken out carefully and put by themselves, and then after removing the bottom the glass can be quickly cleaned with the aid of water and fine sand, or rotten-stone.

FEEDING

Should be performed twice or thrice a week, and will be as amusing to the observer as gratifying to the fishes. Bread is not so objectionable as many have stated. Carp, bleak, and minnows eat it greedily, and soon grow tame if regularly fed with it. Most small fishes take insects, such as flies, spiders, ants, and soft larva, greedily; but the large fish disdain such diet. Small red worms, and white of egg, are good general foods, and seem highly beneficial. When feeding, see that the carp and tench get enough, for they are slow fish, and get robbed wholesale by their more lively neighbours. Food not eaten will decay, unless speedily removed, hence care must be exercised on this head. The general prejudice against bread is the result of the wholesale way in which it is generally given, so as by its putrefaction in the vessel to prove a poison

instead of a diet. Used moderately it may at any time take the place of insect food, when the latter is not procurable. During very cold weather food must be withheld, for it will only remain untouched at the bottom of the vessel to do mischief.

EXHAUSTION OF OXYGEN

Is made manifest by the fishes coming to the surface to gulp air, and it is also manifested by their retiring to the bottom, and quietly extending themselves on their backs in "horizontal repose"—the repose of death. If too many animals be crowded into the vessel, this will soon happen, and either the number must be reduced or the water must be frequently changed, or we must have recourse to aeration, the necessity of which marks very bad management indeed.

TEMPERATURE.

If the Aquarium be too much exposed to the heat of the sun in summer, or to the heat of a fierce fire in winter, the water will get tepid, and signals of distress will be shewn by the protrusion of many panting mouths at the surface. If the temperature rises above sixty degrees, things do not go on so well as they should do, but forty degrees is a safe winter average. The use of a blind or paper screen will be essential in summer time if the vessel is in a south exposure.

On winter evenings, when the room is made cozy by blazing blocks of coal, the collection will often shew signs of distress. By opening the lower window-sash one or two inches when leaving the room for the night, things may be restored to a normal state in a few hours, and even if the weather is somewhat severe no harm will be done. At the same time intense cold throws the fishes

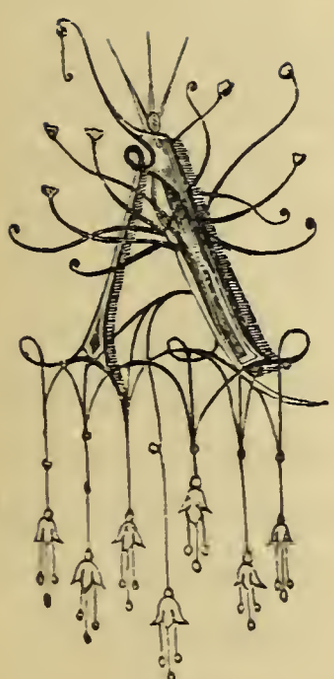
into a state of torpor, and the freezing of the water may cause the bursting of the tank.

In summer time, if the tank should get accidentally heated, it may be quickly cooled by wrapping around it a coarse cloth saturated in water, and keeping it wet from time to time. These matters may be much simplified by fixing a small thermometer within the tank below the level of the water.

The care of the sick and the removal of the dead need give but little trouble to the sanitary inspector. Properly managed, it is rare that any of the animals decline in health. Overcrowding, sunshine, and the presence of decaying matter will cause the outbreak of disease of a fungoid character, from which the fishes attacked rarely recover. If the collection is managed according to the rules here laid down, disease and death will be unusual occurrences. All that can be done with a diseased fish is its removal to a shallow vessel, in which it can rub itself among sand and pebbles. Dead specimens must be removed as quickly as possible. Bivalves are generally very hardy, but if death happens to one, the production of sulphuretted hydrogen is very rapid, and quickly fouls the tank.

CHAPTER VI.

BOTANY OF THE AQUARIUM.



ALTHOUGH I have uttered a proscription against the mode which has long prevailed, of stocking fresh-water tanks with every form of aquatic vegetation that the rivers and brooks present to the collector, I need not for that reason erase the names of the plants that have become favourites with the cultivators of the Aquarium; because the least suitable may be adopted during the season of their blooming, for purposes of ornament and study, and some others unexceptionably useful as adjuncts to the natural system of management. The matter of chief importance is that the least suitable plants should be considered as temporary occupants only, and that the lower forms of fluviatile vegetation should be trusted to for the principal supply of oxygen. In offering a few notes on the vegetation of the tank, I shall endeavour to group the plants together in the order of their utility, without violation of botanical principles.

FLOWERLESS PLANTS, OR CRYPTOGAMS.

The *Cryptogams* are divided into two great sections, namely, *Acrogens*, which have distinct stems bearing leaves and branches; and *Thallogens*, which have no distinct stem or leaves, but consisting only of a cellular

expansion, varying in form in the several orders, and on which the organs of reproduction are developed. As the *Thallogens* are the lowest in the scale and the most useful as producers of oxygen, we will speak of them first.

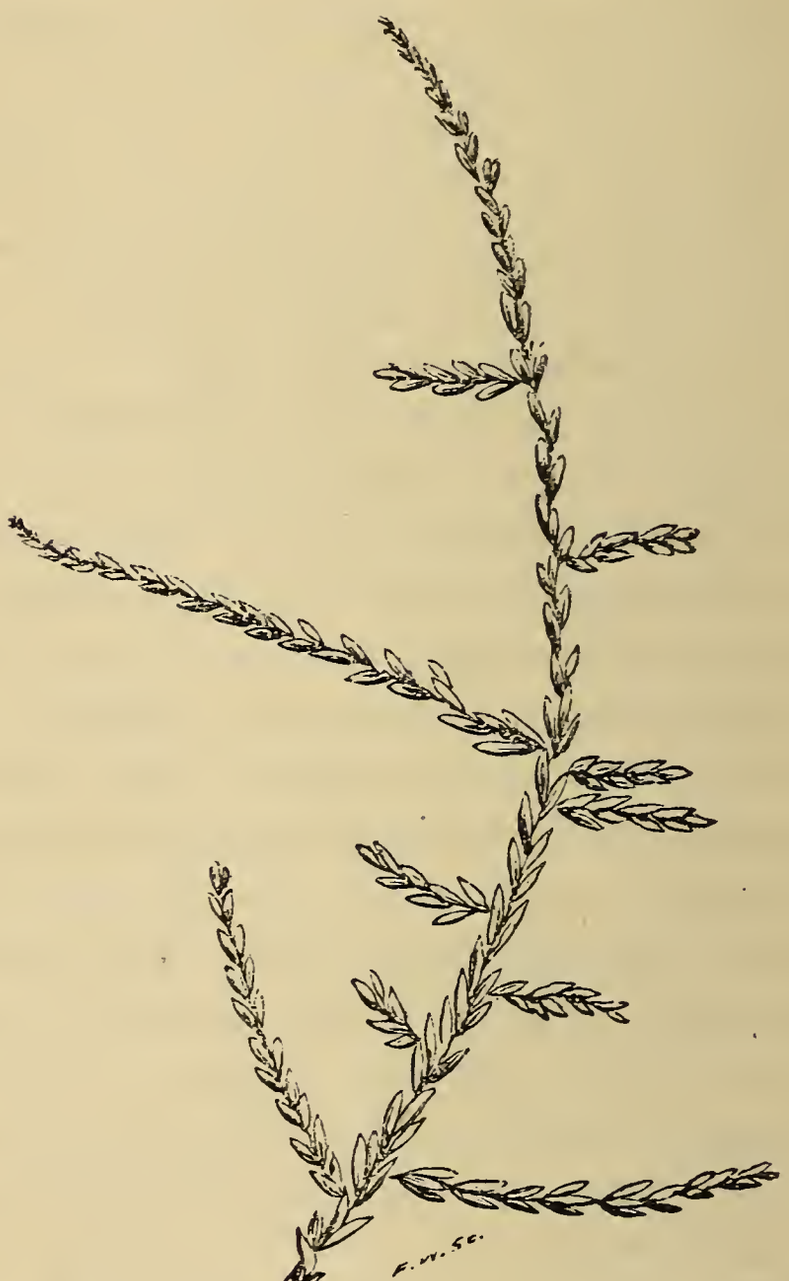
Very many of the *Thallogenous* plants will become occupants of the vessel in a brief space of time after it has been fitted up, and they should be encouraged as the most useful department of its vegetation. Others that do not occur by spontaneous growth can be introduced, and if they be made subjects of special study it will be well to keep univalve mollusks out of the vessel altogether. The confervæ, or silk-threads, are well known as forming a soft green carpet on every submerged surface to which light has access in every part of the vessel. If micha schist is used in the construction of the rock-work, a rich spontaneous growth of confervæ will take place very quickly. The species of confervæ are very numerous, and their whole history full of interest, as are also the species of the brittleworts, or *Diatomaceæ*, and others of the great order of algæ, to which these cellular plants belong. The yokethreads, *Zygnemata*, and the *Oscillatorieæ*, so charmingly described and figured by Mr. Tuffen West in the pages of "Recreative Science," furnish subjects for the study of a lifetime under the microscope, and ably perform their part in the Aquarium, as purveyors of oxygen. Among the kinds to be specially sought in this order, *Vaucheria ungeri* should stand first as an example of that intermediate form of life which Ehrenberg classed with the animalcules, but which is a true algæ, which reproduces its kind by means of zoospores furnished with cilia, which enable them to swim about for a time before they become fixed and developed into true vegetables. *Prolifera rivularis* and *Conferva glomerata*, present similar phenomena varied

in form. *Hydrodictyon utriculatum*, a very common water-plant, is not so useful in the tank as the majority of its kindred, but it is to be sought for as an interesting object, as strikingly exhibiting the phenomena of conjugation, the whole plant consisting of filaments united into a net-work of exquisite geometric regularity.

Contrary to the conclusion that would be arrived at by a merely casual inspection of the *Charas* and *Nitellas*, they are not classed with the *Acrogens*, because, though they appear as plants possessed of stems and branches, they are in reality as simply formed as any of the lower algæ, being wholly composed of tubular cells, placed end to end; and their propagation is by a duplicate system of antheridia and sporangia. In *Chara* the whole plant is invested with stony matter, which has to be scraped off before a specimen can be used for the purpose of observing the circulation of the sap. If for this purpose only the *Charas* should be preserved with care, and as they are apt to decay after a time in the Aquarium, it is well to keep duplicate specimens in small vessels apart from the general collection. *Nitella flexilis* belongs to the same order, and is distinguishable from *Chara* in its pellucid nature, not being invested with calcareous matter. The *Nitellas* are exquisitely beautiful, and their proper place is in the insect Aquarium, as they can be better managed when in small vessels.

Among the *Acrogenous* plants the mosses and liverworts furnish a few very useful specimens, of which the best is *Riccia fluitans*, a beautiful floating plant of curious structure, which increases by sporules, which appear immersed in cavities on the bright green fronds. The following true mosses may be obtained by the diligent collector, and be located in hollows of the rock-work near the surface, where they will be sure to thrive.

Fontinalis antipyretica, common on sluices and wooden bridges; *Cinclidotus fontinaloides*, *Hypnum ruscifolium*, *filicinum*, *fluitans*, and *riparium*, *Bryum punctatum*, *roseum*, and *ligulatum*.



Fontinalis antipyretica.

FLOWERING PLANTS—EXOGENS.

To do justice to the Aquarium as a water-garden the cultivator should consider it as a show-house, and not as a nursery. Many of the most interesting and ornamental of flowering plants cut but a sorry figure

in it after a lengthened period of incarceration, and their ultimate decay causes vexation and disappointment prejudicial to aquarian interests. The fact is, the majority of them unlike the plants of a lower order of organization, require a good soil to root in, and a plentiful enjoyment of sunshine and fresh air, such as they have in their natural habitats beside the woodland streams and open water-courses. We must come back to the plan adopted by Mr. Loudon, Mr. Jewite, and the horticulturists of the present day, and by its adoption maintain a succession of plants, to be introduced from time to time as they come into bloom, and to be removed back to their proper quarters when their blooming is over.

Aquaria used to embellish entrance halls and conservatories* may very easily be adapted to receive plants in pots to be plunged in pockets in the rock-work, or lowered to the bottom of the tank in pots cased with rough cement, and to be worthy as decorations, of association with the most costly furniture and most tasteful elegancies. Many of our finest greenhouse and garden plants are half aquatic during their season of bloom, as *Agapanthus*, *Richardia Ethiopiæ*, *Tritoma uvaria*, and *Hydrangea*; and the noblest of hardy and exotic ferns luxuriate in positions where a considerable portion of their roots is kept immersed for several months together. To manage the Aquarium on these highest principles, provide a stone trough, a foot deep, and of any convenient length and breadth, according to the extent to which aquatic plants are to be cultivated. At one end there must be a tap to let the water off

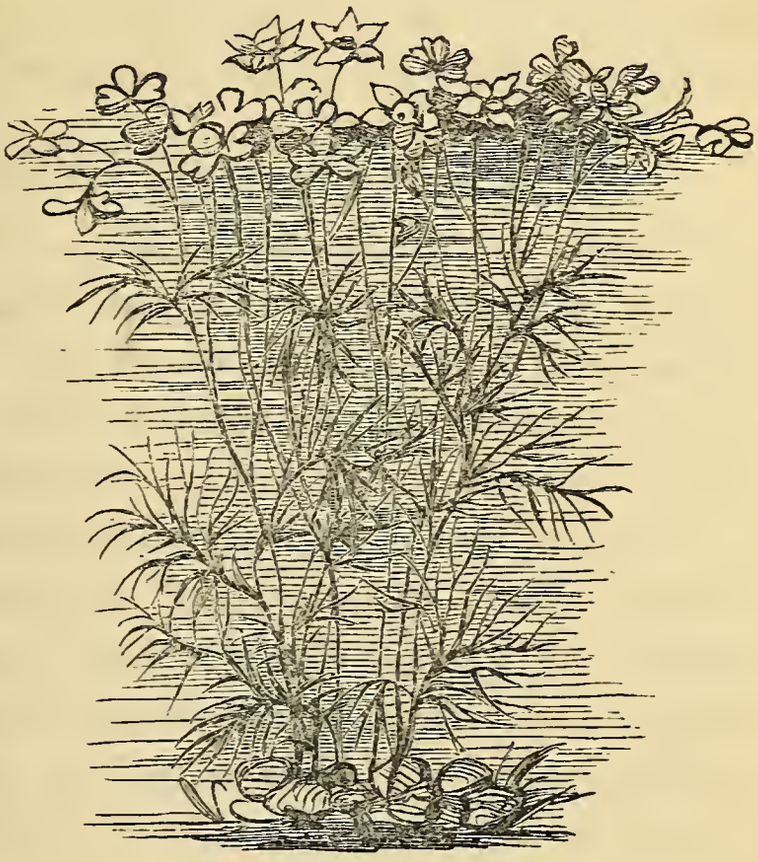
* A conservatory is the worst of all places for an Aquarium containing a general collection, but with proper shading, and choosing the coolest part of the house gold fish may be kept for ornament with very little trouble, and there can be no reason why some of our best aquatic plants should not also keep them company, to help to make the place look like fairy land.

at any time, and at the other a supply pipe. Aquatic plants suited for pot-culture are to be potted in as small pots as they can be got to thrive in, and plunged in the trough, which of course is to be kept filled with water. Plants in small pots, and such others as are but half aquatic can be placed on inverted pots, so as to stand in one or two inches of water only. The appropriation of the plants to the Aquarium as required is thus a matter of removal only. True aquatics must be kept wholly plunged, and a stone basin or fishpond or a trench two feet and a half deep, lined with cement and supplied with water kept gently on the move towards an outlet will be the proper nursery. I have a couple of large tubs coated with pitch inside and out for this sort of culture. One of them has a pipe from the New River works, and a siphon formed of half-inch lead pipe passes from it to supply the other. In these I stand on inverted pots or short lengths of drain-pipe of large diameter, pots containing *Pampas Grass*, *Poa aquatica*, *Calamagrostis*, *Richardia*, *Athyrium*, *Osmunda*, etc.; and though they form beautiful masses of vegetation in their places, they are frequently useful as furniture for aquaria and the entrance hall. The majority of such plants may be wintered in a cold pit, but the true aquatics must be kept plunged all the year round. The horticultural reader will see in this plan a rather wide field of enterprise for perseverance and ingenuity.

RANUNCULACEÆ.—ORDER I.

Water Crowfoot, or *Ranunculus aquatilis*.—A member of the honourable family of buttercups, is well known to ramblers in the country. It is to be found in almost every pond, and by the middle of May is in full bloom, continuing gay till far into autumn. The

blossoms are snow white, with a bright yellow centre. If you step carefully to the edge of a pond or river, where this crow-foot covers the shore-water with its floating foliage and thousands of snow-flakes, you will not be in a hurry to disturb it, it is so truly beautiful. But reach forth your hand, and tenderly take up a head; and, as you draw it from its plashy bed, you will find that it is truly amphibious in structure, no part of the undergrowth being at all like that which floats above in the air and sunshine. The floating leaves are fleshy and neatly lobed, the lower ones are as finely cut as fennel, and from every joint numerous white rootlets will be seen protruding, on their way to find root at the bottom. This plant requires good washing in clear water before it is fixed in the tank, or it may be the means of introducing many objectionable growths. It will be best to cut away the lower portions, and gather the chosen pieces together, and attach a stone to them by means of a strip of bass. It will last three or four weeks, and is then to be thrown away. A quantity of short blossom heads may be spread over the tank with the flowers on the surface, in which position it will in a couple of days arrange itself neatly, and hold its blooms well up, and may be allowed to remain until all the buds have expanded. It is not worth growing, though a



very interesting plant. The refuse after trimming and washing should be put into a spare vessel for microscopic purposes; it is always rich in ordinary forms, and sometimes contains good specimens of *Hydra.*

NYMPHACEÆ.—ORDER VIII.

WATER LILY, *Nymphæa alba.*—In this order we have numerous lovely aquatics to be seen in perfection only in ornamental waters, and the tanks at Chatsworth, Kew, and Sydenham, among which is the *Victoria Regia.* The *Nelumbium* is grouped in a separate order.

To grow the white water-lily, the stately queen of our British lakes and streams, requires great depth and extent of surface—more than an ordinary tank will afford, even for its occasional reception, and it is a difficult plant to move when in bloom, owing to the extent to which it spreads its roots. It is a delicate plant too, and needs a very pure air, so as to fit it only for a large tank in a conservatory, or an open-air pond; but the yellow lily, *(Nuphar lutea,)* will occupy little more than a square foot of surface, and one of these will flourish in-doors with ordinary care, and add a bold grace and reality to the mimic lake. The other lilies that are most suitable are *Nymphæa odorata minor*, and *Nymphæa macrantha.* The most generally useful is *Nuphar lutea*, and the best way to treat it is to plant it in a broad shallow pot, and lower it into the tank. In this way it will grow luxuriously for one season, and must be transferred to the fishpond for the winter, or thrown away, as the decay of its leaves would do much mischief in the tank.

CRUCIFERÆ.—ORDER XIII.

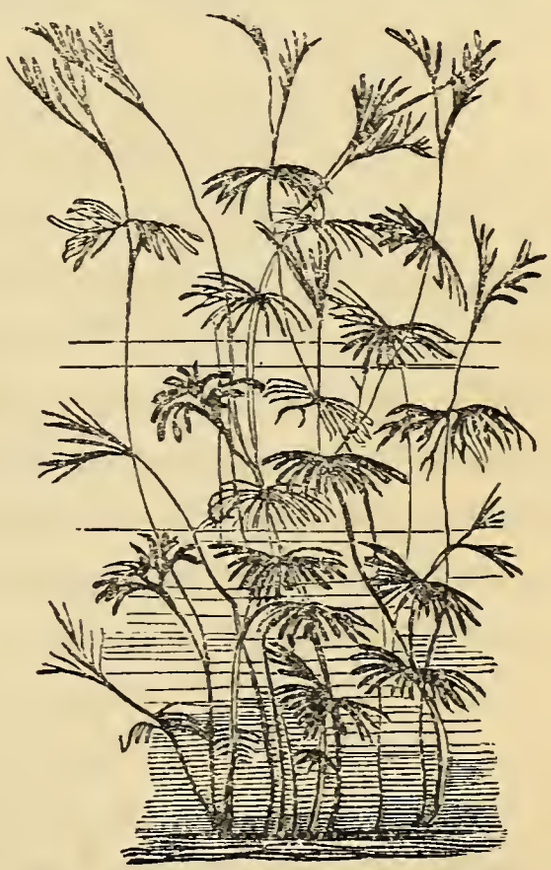
WATER-CRESS, *Nasturtium officinalis*, is a very pretty plant in the tank, and occasions but little inconvenience,

but it will not last long in good condition, and should be removed as soon as it shews signs of decay. To sow seeds of it in the Aquarium is the beginning of vexation: it needs rich soil, fresh air, and abundant light to maintain its growth as a plant.

Awlwort, *Subularia aquatica.*—A scarce but very beautiful plant, found in still lakes in the North of England. It produces both leaves and flowers under water, and is very suitable for a bell-shaped vessel which has constant attention.

HALORAGIACEÆ.—ORDER XCI.

Water Milfoil, *Myriophyllum spicatum.*—This is the most common species of a family which claim permanent occupancy as clean in their growth, good manufacturers of oxygen, and bearing the confinement moderately well. The leaves are arranged in whorls, and the flowers are also in whorls.



Mare's-tail, *Hippuris vulgaris.*—This plant has an upright-jointed stem, with the leaves set in whorls of about eight round it. It requires soil, and is worth pot culture. It may be found in most deep streams of slow current.

GENTIANACEÆ.—ORDER CXXX.

Villarsia Lily, *Villarsia nymphæoides.*—A charming lily-like plant, so named in honour of Madame Villars,

the accomplished author of the "Flora of Dauphine." The leaves float on the surface in the fashion of a lily, and the large yellow flowers are borne on small stalks conspicuously. It will well repay careful cultivation in a pot submerged out of doors, or in a tank in a greenhouse, to be placed in the Aquarium when in bloom. It is one of the first ornamental aquatics that a lady aquarian should procure.

Buckbean. *Menyanthes trifoliata.*—A pretty half-aquatic, abundant in marshy places throughout Britain. It has bold three-lobed leaves, and produces a profusion of pretty white-bearded rose-coloured blooms in May and June. Will not do for a permanent place in the tank, but an excellent plant to grow in a pot plunged to the rim.

PRIMULACEÆ.—ORDER CL.

Water Violet, *Hottonia palustris.*—The foliage of this is in finely-divided comb-shaped whorls, coarse, and not very sightly. The blooms are purple and yellow, and come in whorls, and are very ornamental. The leaves are wholly submerged, but the blossoms rise above the surface. It is a dirty plant in the tank, and never prospers as a permanent inmate, but is worth growing out of doors.

SCROPHULARIACEÆ.—ORDER CXLV.

Brooklime, *Veronica beccabunga,* and Water Speedwell, *V. anagallis,* two neat plants with blue flowers, are both common in clear ditches, ponds, and brooks. The brooklime has a procumbent stem, and the speedwell an upright one. They require soil for their roots, and can only be used for a short period in the Aquarium. The Water Betony, *Scrophularia aquatica,* also common beside ditches, may be dealt with in the same manner.

CALLITRICHACEÆ.—ORDER CLXXXI.

Water Starwort, *Callitriche verna*.—This cheerful inhabitant of almost every pond in the country is often called water chickweed, as it forms a dense mass of bright green foliage on the surface of the water, which has the same appearance as chickweed on a bank. It is a most useful Aquarium plant, though Mr. Lloyd classes it as only second-rate. In one sense he is right, for it does not flourish the year round, and must be removed as soon as it begins to shew signs of decay. It has one special value for those who are in haste to see their vessels look gay. A mass of it picked over and washed, and then tied in tufts and moored to the bottom, will at once supply plenty of oxygen, and plenty of food for the fishes, and a quantity of the short tops may be sprinkled over the surface, where it will float like duckweed, and make the tank complete instanter. It soon spreads over the surface, and arranges itself most beautifully, forming a rich green ceiling, giving the verdant shadow which a new tank wants; it grows freely, lasts for months, continually throwing out new roots and shoots from the joints, and creates abundance of oxygen, from the first hour of its being thrown in. Whenever it seems desirable it can be got rid of by simply lifting it out. The leaves and stems, and the minute blossoms are charming under the microscope, and



many of their beauties may be observed with a common hand-lens.

CERATOPHYLLACEÆ.—ORDER CLXXXII.

HORNWORT, *Ceratophyllum demersum*.—A common plant in ponds and ditches. The leaves are slender and filamentous, and arranged in whorls around the stem. It is not cleanly in its growth, but may be allowed to float about the tank for a week or two, if brought home with brook gatherings.

ENDOGENS. HYDROCHARIDACEÆ.—ORDER CCXXV.

VALISNERIA SPIRALIS is the best of all Aquarium plants, and one of the most interesting also, both for its beauty of structure and habit of growth. As a subject for exhibiting the circulation of the sap it is popular with microscopists, and there is not a more wonderful spectacle in the whole range of microscopic phenomena. The plant has perennial roots, and thrives best in a bed of four inches of loam covered with pebbles, but will do in pebbles only. It must be well established before it will flower, and then it is seen to be dicœcious, that is, the stamens and pistils are produced on different stalks. The male or stamen-bearing blossoms appear on short foot-stalks, and after a time they are detached and rise to the surface, where they float about the female or pistil-bearing flowers, and so fertilize them. These female



flowers are borne on long spiral stalks in the fashion of corkscrews, which elongate or contract according to the depth of the water, and thus impregnation always takes place at the surface. When this has taken place the spiral stalks contract, and the newly-formed seeds are thus drawn down into the soil, where they take root and become new plants. Though the two kinds of blossoms are usually produced on different plants, I believe the same plants occasionally produce both.

Water Thyme, *Anacharis alsinastrum*.—This is also a first-rate Aquarium plant, which appears never to die out unless the tank is very badly kept, and the smallest fragment is sufficient to produce good tufts, as it roots rapidly from the joints along the stem. It thrives without soil, and is a good producer of oxygen. The history of this water-weed is interesting, and has been variously related. It appears to have been first noticed by Dr. G. Johnston, in a pond at Dunse Castle, Berwick, in 1842. Dr. Johnston sent some of it to Mr. Babington, at Cambridge. There it speedily increased in the Botanic Garden, and was turned out into the Cam, where it soon displayed its real character as an obstructor of river navigation. In a similar way it escaped from Kew into the Thames, and is now extensively distributed throughout the country. It is a native of North America, where it is described by Nuttall under the name of *Udora Canadensis;* the genus had however previously received the name of *Anacharis*, from Richard. Its only fault as an Aquarium plant is that in a good light it grows too fast; but it is a mere moment's work at any time to bring it within bounds, if it threatens to choke the tank. Only female plants have yet been seen in this country, and when the minute but pretty blooms appear in July they are most interesting objects. Strong tufts, obtained fresh from a stream

in April or May, will be sure to blossom in the tank; but when made a permanent inhabitant it becomes too weakened in constitution to bloom after the first season.

Frog Bit, *Hydrocaris morsus-ranæ*, is a floating plant which produces lily-like leaves on the surface of the water, with the rootlets dependent from the base. It is a valuable Aquarium plant for a tank in which there are no water-snails, and will grow and bloom freely, and continue to increase from year to year. A very few *Lymnea* suffice to clear away a large stock of this plant in a few weeks, and the less voracious of the water-snails are partial to it.



Water Soldier, *Stratiotes aloides.*—This is not plentifully distributed, but where it is found it is usually very abundant, as in some of the ponds in Epping Forest, some parts of the Lea near Hackney Wick, and on Wandsworth Common. It may be known by its unique style of growth, the plant resembling the tuft on the top of a pine-apple. It prospers equally with or without a root, and in spring throws up from the joints near the base a number of young plants on long stalks, which in the course of time detach themselves,



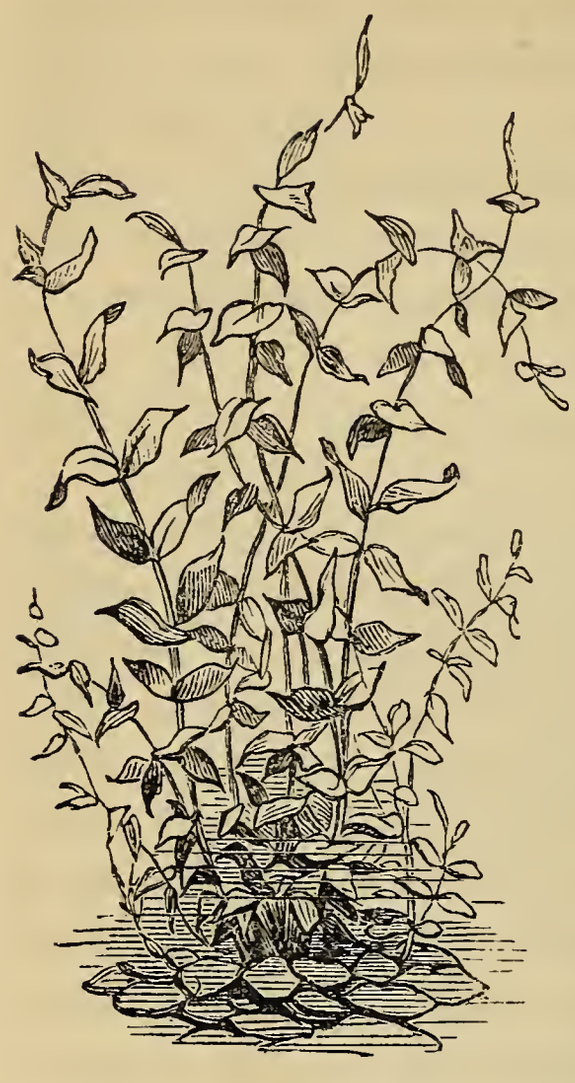
and become independent. These young plants generally send down long, cord-like, pellucid green roots, which insinuate their spongioles among the pebbles, and hold the plants in anchorage, but with full liberty to rise to the surface or sink to the bottom as the specific gravity of the plant alters with the changes of the seasons.

LEMNACEÆ.—ORDER CCXLII.

Duckweeds. The species of this curious family are excellent surfacing plants for the Aquarium, and among the most remunerative as objects of study. They are true flowering-plants, the male and female organs being separated, but very distinctly produced; the one contains two stamens and the other one pistil, and both kinds of blossoms produced on the margins of the fronds during the month of May. The following are to be sought for and compared with each other:—*Lemna trisulca*, three-lobed; *L. minor*, compressed and nearly rounded fronds; *L. gibba*, fronds gibbous and spongy, and larger than the last; *L. polyrhiza*, many-rooted, the others have single roots: this has many, and its fronds are rounder than the last.

JUNCAGINACEÆ.—ORDER CCXIV.

This family of fresh-water flowering-plants offers to the river tank the interesting British and exotic Pond Weeds.—All the species are of questionable value as permanent occupants, except the pretty fennel-leaved pond weed, *Potamogeton pectinatus*, which has a grassy appearance in clear swift-running rivers, where it often clothes the bed for miles with a wealth of rich deep bluish green foliage. This is the best of the family. The opposite-leaved pond weed, *P. densus*, has ovate



Potamogeton densus.

leaves without stalks, crowded round the stems; very common in ditches, and does not last long in the Aquarium. The grassy pond weed, *P. gramineus*, resembles *P. pectinatus*, and is clean in its growth, and of some endurance. *P. crispus*, the curly pond weed, is an abundant species in ditches everywhere, and of very good habits in the tank, where it has sufficient light. *P. fluitans*, the floating pond weed, is tolerably useful, but very apt to shed its leaves and cause discolouration of the water. The botanical student is advised to collect the members of this interesting tribe, and bring them under culture in the water-garden, for use in the tank when their blossoms are produced.

Cape Pond Weed, *Aponogeton distachyon*.—Though usually treated as a greenhouse aquatic, this elegant plant thrives in open-air aquaria in the climate of Britain, even as far north as Edinburgh. Its elegant white blossoms are produced from May to nearly the end of the year under generous treatment, and it is one of the very first among ornamental plants to be chosen by the cultivators of taste in Aquarium matters. It should be grown in a pot, plunged, and used in the Aquarium for decorative purposes only. The other greenhouse species, *A. angustifolium*, is also worthy of a place in the collection.

ALISMACEÆ.—ORDER CCXIII.

All the British members of this order are handsome plants, and flower and fruit freely in a very circumscribed space. The best way to use them is to grow them in pots plunged in a garden Aquarium for decorative purposes. Complete plants may be taken up from the river-side when in full bloom, and have the earth washed away from their roots, and be planted amongst the pebbles in the bed of the Aquarium without suffering the least damage.

Water Plantain, *Alisma Plantago*.—The fine foliage of this plant gives it a noble aspect, and though it is quite unsuited for permanent planting in the tank, it may be well grown, and will flower freely without a particle of soil for its roots. A few years ago I distributed among some amateurs a large quantity of seed, that ripened on a plant grown in a twenty-inch bell-glass, and very many of them raised plants from it. Some that I sowed in a pot of peat, plunged to the rim in water, came up very strong, and a few chosen seedlings grew vigorously under the same treatment as the parent had received, so that the vigour of the species was not much deteriorated by artificial treatment.

Arrow-head, *Sagittaria sagittifolia*.—This is bold and handsome, but not well suited for any but a large tank, and then only for a few weeks. The star fruits, *Damasonium*, may be classed with the last-named as of temporary value only.

Forget-me-not, *Myosotis palustris*, Flowering Rush, *Butomus umbellatus*, and *Thalia dealbata* ought not to be omitted at least a mention here as aquatics of great beauty, but quite unfit for the normal economy of the Aquarium.

CHAPTER VII.

ZOOLOGY OF THE AQUARIUM.

THE heart is hard in nature, and unfit
For human fellowship, as being void
Of sympathy, and therefore dead alike
To love and friendship both, that is not pleased
With sight of animals enjoying life,
Nor feels their happiness augment his own.

COWPER.



HE comfort of a reasonable joy" is certainly attendant on the care of animals, when that care is controlled by humane feelings and a desire to see the creatures happy. The Aquarium is at least one of the many aids towards the cultivation of kindness, and the enlargement of general knowledge which the Home of Taste affords. A veteran angler who has long ago mastered all the refinements of his cruel craft, will here be taught that after all he is still ignorant of even the ordinary appearances and habits of fishes. Accustomed to study how and when they take the bait, familiar with their agonies when the bait has been gorged, dead to the repugnance which the sight of suffering innocence should inspire, he will yet be moved and astonished by the contemplation, for a quarter of an hour only, of a well-stocked river-tank. A century of angling

experience will not afford so much knowledge as would be gained by that quarter of an hour's inspection. Here are bleak and minnows, that sport about like kittens, that play with each other, and indulge in such comical pranks as make one shudder at the idea of *hooking* such pretty creatures. Here are plump carp that glide easily about, and that become as familiar as the cat on the hearthrug; tench, that roll on their backs and submit to be tickled, and that nibble the fingers of their proprietor with a confidence with which we may well believe affection is mingled. It is rare fun at all times, and we get so enamoured of the confiding creatures, that I think it impossible for any one with a spark of genuine humanity to warm his breast, to continue an angler after having once taken to the care of a tank. But the interest does not end with fishes proper, because this contrivance enables us to observe the habits and study the history of numerous tribes lower in the scale of creation, where the lack of intelligence is compensated by peculiarities of organization, that more or less illustrate the phenomena of life in its highest functions.

VERTEBRATÆ—FISHES.

In grouping fishes attention must be paid to their habits and relative power of enduring confinement. Experience proves that it is most injurious to group them indiscriminately, on account of the voracity of some kinds, and the pugnacity of others; neither are our British fishes equally capable of enduring the confinement of the tank. The most hardy are the sticklebacks, carps, tench, minnows, stone loach, gudgeon, eel, and jack. The sticklebacks are not at all times to be trusted with fishes of gentler disposition, nor is the voracious jack to be trusted with minnows. The least hardy of the kinds usually

introduced to aquaria are the miller's thumb, the perch, dace, bleak, bream, and chub. A few notes on the most interesting may be best grouped under the respective heads of sharp-finned, *Acanthopterygii*, and soft-finned, *Malacopterygii*.

ACANTHOPTERYGII.

Perch. *Perca fluviatilis*.—This handsome fish will live a long time in the tank if the possessor will be content with small specimens. It eats voraciously any kind of soft insect food and small earthworms, and cannot endure any undue heat; indeed it is during hot summer weather its death usually occurs.

Stickleback. *Gasterosteus*.—All the seven species are good Aquarium fish, if kept in separate vessels apart from the general collection. Their vivacity, tameness, and love of fight and frolic, entitle them to every careful consideration, but their social history gives them the first place among household finny pets, not excepting even the showy golden carp. The stickleback is one of the few fishes possessed of strong domestic instincts, manifested in the construction of a nest, and a watchful care for the young. Dr. Lancaster describes this trait very pleasingly in his "Aquavivarium," as follows:—

"He has all the way of other fishes and many more besides. Look into your tank, see, there is one larger than the rest: he is clothed in a coat of mail like a knight of old, and it is resplendent with purple and gold. See how his eyes glisten, and with every movement present a new colour. He is a male fish, the king of your little shoal. He has important offices to perform. Presently, in the course of a few days, if you watch him, and are fortunate, you will see this wonderful little fish engaged in the most useful manner in building a nest. He first seizes hold of one little bit of weed, then

of another, and carries them all to some safe corner, till at last his nest is built. Having done this, he gently allures his mate to his new-made home. Here she deposits her eggs, and having done this, resigns the care of them to our hero of purple and gold, who watches over them with an anxiety that no other male in creation but the male stickleback seems to know. He fans and freshens the water with his fins, and at last, when the young are hatched, watches over their attempts at swimming with the greatest anxiety. Nor is this habit confined to the fresh-water sticklebacks. A lady, writing to me from Aberdeen, and describing her aquavivarium, says, 'A fifteen-spined stickleback, *Gasterosteus spinachia*, constructed a nest on a piece of rock, which was covered with a fine green sea-weed, depositing the spawn first, then covering it with loose sea-weed, and lacing all together with a long thread, composed, apparently, of some secretion. The fish afterwards, for about the space of three weeks, watched the nest, never leaving it at all, save for the purpose of driving away the other fish when they approached too near. When a stick was introduced into the vicinity of the nest, the fish would fly, open-mouthed, to attack it, and would bite it with great apparent fury. At the expiration of the above-named time, the young fry made their appearance by hundreds; but I am sorry to say they soon disappeared, being devoured by the other fish, and caught by the tentacles of the sea-anemones. The mother fish continued her attendance at the nest as long as any of the young fry were left.'"

Another interesting fact in the constitution of *Gasterosteus*, is that the marine and fluviatile kinds readily change places with each other. I have taken *G. pungitiis* from the river tank, and dropped it among sea-anemones, and the only inconvenience he appeared to suffer was

want of a due degree of specific gravity to keep himself under water. In spite of his utmost efforts the sea-water buoyed him up, tail foremast, to the surface, and he employed his pectoral fins vigorously in attempts to get to the bottom. On the other hand, *G. spinachia*, removed from the marine to the river tank, found himself too heavy, and though a little uneasy by the sudden change, put up with it composedly, and was very soon at home. When made to pass through degrees, as a first change from fresh water to diluted sea-water, then to sea-water a few degrees stronger, and *vicê versâ*, their specific gravity alters more readily to the circumstances.

As many aquarians aver that sticklebacks may be kept all the year round with other fishes, I must repeat the warning to the beginner to be careful, or he may regret having made their aquaintance. They are all savages, untameable savages, that delight in destruction, even if they cannot eat what they destroy. They will attack anything, and, with their spiny armour, dare the stoutest to retaliate upon their mischief-making pertinacity. In fact, they pass all their time in worrying the more peaceful members of the Aquarium; and any one who has a few months experience of them, will consider them the savagest of imps.

MALACOPTERYGII.

British Carp. *Cyprinus carpio.*—A handsome fish, differing slightly in structure from the Prussian and gold carp, yet in general outline, preserving the true carp type—plumpness of body, iridescence of colour, and ease of movement in the water. This carp has a barbule at the upper part of each corner of the mouth, and a second one above it, on each side. Like the rest of its kindred, it is very tenacious of life, and does not quickly suffer from exhaustion of oxygen. It is an old fish, so to

speak, for it was a favourite with the ancients. Pliny and Aristotle both speak of it in high terms of praise, and record that it lives to a hundred years of age, becoming, in that time, as white and hoary as an "ancient mariner" should. It is not indigenous to our rivers, though, as far back as 1496, mention is made of it in



GUDGEON, PRUSSIAN CARP, LOACH, AND BREAM.

the "Boke of St. Albans," quoted by Mr. Yarrell. It has been known to attain to a weight of twenty pounds, and in Holland is frequently kept alive in wet moss, and fattened on boiled potatoes. In this way it is said to live three weeks.

Prussian Carp. *C. gibelio.*—Is unquestionably the best of all fishes for aquarian purposes. It will survive

the wreck of a whole establishment, even if the water gets putrid and almost exhausted of oxygen. The easy, graceful motions, the beauty of the colouring, and the docility of this fish, must make it a favourite and a pet wherever it is kept. I have always had a large number of them, some of considerable size; they group themselves like friends on good terms of acquaintance, take an interest in whatever goes on in the room where the tank stands, and elegantly poised in mid-water, will watch their proprietor for hours. Small, red earth-worms, young water snails, and home-made bread, are the best of foods for them. They will seldom eat bread at first, but soon get to like it, eat it greedily, "and ask for more." The Prussian carp may be taught to feed from the hand, even more boldly than the minnow, and readily assemble themselves for inspection when the side of the glass is gently tapped with the finger-nail. None of the carp family are carnivorous in any great degree. Mr. Yarrell says the Prussian carp will recover after having been thirty hours removed from water.

Crucian, or German Carp. *C. carassius.*—Is easily distinguished from its compeers by its bream-shaped back, which rises from the nape into a high arch along the line of the dorsal fin. It is to be found in the Thames. between Hammersmith and Windsor, whether for the angler to kill or the aquarian to preserve. It is less hardy than the Prussian carp, and a little subject to fungoid growths.

Gold Carp. *C. auratus* of Linnæus.—Will hold pre-eminence among domestic fishes for its splendour of colouring, though among naturalists I think the Prussian carp will always compete with it to advantage, for the gold fish is certainly the dullest-minded of the family, and, like most fops, lazy and unteachable. Pennant says, "In China every person of fashion keeps them for

amusement, either in porcelain vessels, or in the small basins that decorate the courts of the Chinese houses. The beauty of their colours and their lively motions give great entertainment, especially to the ladies, whose pleasures, from the policy of the country, are extremely limited." This carp appears to have been introduced into Britain about 1611, though the precise date is difficult to determine. Mr. Yarrell leaves it an open question. A large number of those reared for sale are the produce of waters which receive the waste steam from factories, and which are thus kept to a temperature frequently as high as 80°. In fact this carp is most prolific in tepid water, though those that are bred at a lower temperature are more beautiful. The gold carp is not the only fish that can bear such high degrees of heat, perch and mullet have been found in waters at 86°; live eels were found by De Saussure in water heated to 113°, and other instances, mentioned in Bushnan's "Study of Nature," shew the adaptability to temperature in fish of many other species.

This trade has been so long established that a modern gold fish is truly a manufactured article, and the patterns vary from high class beauty to very decided deformity. Domesticated creatures are all liable to vary from their original type, but in the gold carp this variation proceeds to an extent not observed in any other animal which man has taken under his care. Their colours are as various as their forms; some have stumps instead of dorsal fins, with perhaps tails as large as their bodies; some have triple-forked tails, and perhaps no trace of a dorsal fin at all, and in purchasing, it is as necessary to look to the structure and outline of the fish as to its colours, or, on after-inspection, the purchaser may find himself in possession of creatures as bright as morning sunshine, but in form as ugly as toads. There is no

better food for gold fish than the crumb of bread or biscuit. Many writers condemn this; I can only say that they thrive for years upon it, but if more be given at a time than the fish can eat, it soon renders the water impure and does mischief.

Bream. *Cyprinus Brama.*—Is a fish of bold outline and pleasing habit, not very long-lived in confinement. The depth from the dorsal to the ventral fin is nearly equal to the length of the body, and justifies the comparison applied to a high-shouldered biped, "backed like a bream." There is a prettier species called the *Cyprinus Buggenhagi,* (Pomeranian Bream,) which is decidedly rare.

Dace, Roach, and Bleak. *C. Leucisus,* (the dace,) *C. rutilus,* (the roach,) and *C. alburnus,* (the bleak.)—May be classed together, as fishes well known to all who were ever seduced into playing truant, to try their boyish luck with a blood-worm and a bent pin, or who have since sunned themselves in the holiday pages of Izaak Walton, to fall in love with milkmaids, and dream all night of reedy rivers that sing and sparkle, and fishes fried in meadow cowslips. These are delicate fish, whether for the table or the tank. As the latter concerns me most here, let me warn the reader to proceed cautiously, for these lovely creatures have a sad habit of perishing quickly in confinement. In winter time they may be kept with ease, but as spring approaches, the best care for them will only be rewarded by the spectacle every morning of one or two floating on the surface, never to swim again; while they do live, there are no more interesting creatures to be found for the gratification of the domestic circle. Bleak are even more sportive than minnows, and will chase a fly or small spider thrown in to them, till they tear it into shreds, and then will fight like Irish lads for the pieces. Dace are very tameable,

and soon grow bold and familiar in captivity, comporting themselves in their attitudes and motions much like Prussian carp. Of the three, dace are the most hardy, the other rarely live the summer through.

Minnow. *C. phoxinus.*—An Aquarium without minnows is no Aquarium at all—it is a makeshift. With a shoal of minnows and a few Prussian carp an Aquarium may be considered fairly stocked, because there is really something to look at, something to amuse, and something to instruct. The minnow is a bold and impudent fish; he is at his ease in less than an hour, and in a week will shew a sign of attachment and familiarity. They do not live beyond three years, but will reach that age in the confinement of a tank. The colours are pleasing, and bear some close resemblance to the mackerel; but fright will make them assume a pale fawn-colour in an instant. Disease seldom attacks them. Minnows spawn in June, and just before that time acquire their gayest mottlings of green, and bronze, and silver, losing colour considerably after spawning.

Gudgeon. *C. gobio.*—Is an every-day sort of fish, proper enough in a general collection, but where room is scarce it may very well be spared. In its markings the gudgeon has a striking appearance. It is a hardy fish, and rarely shews signs of exhaustion, even in a crowded tank, but it cannot endure a high temperature.

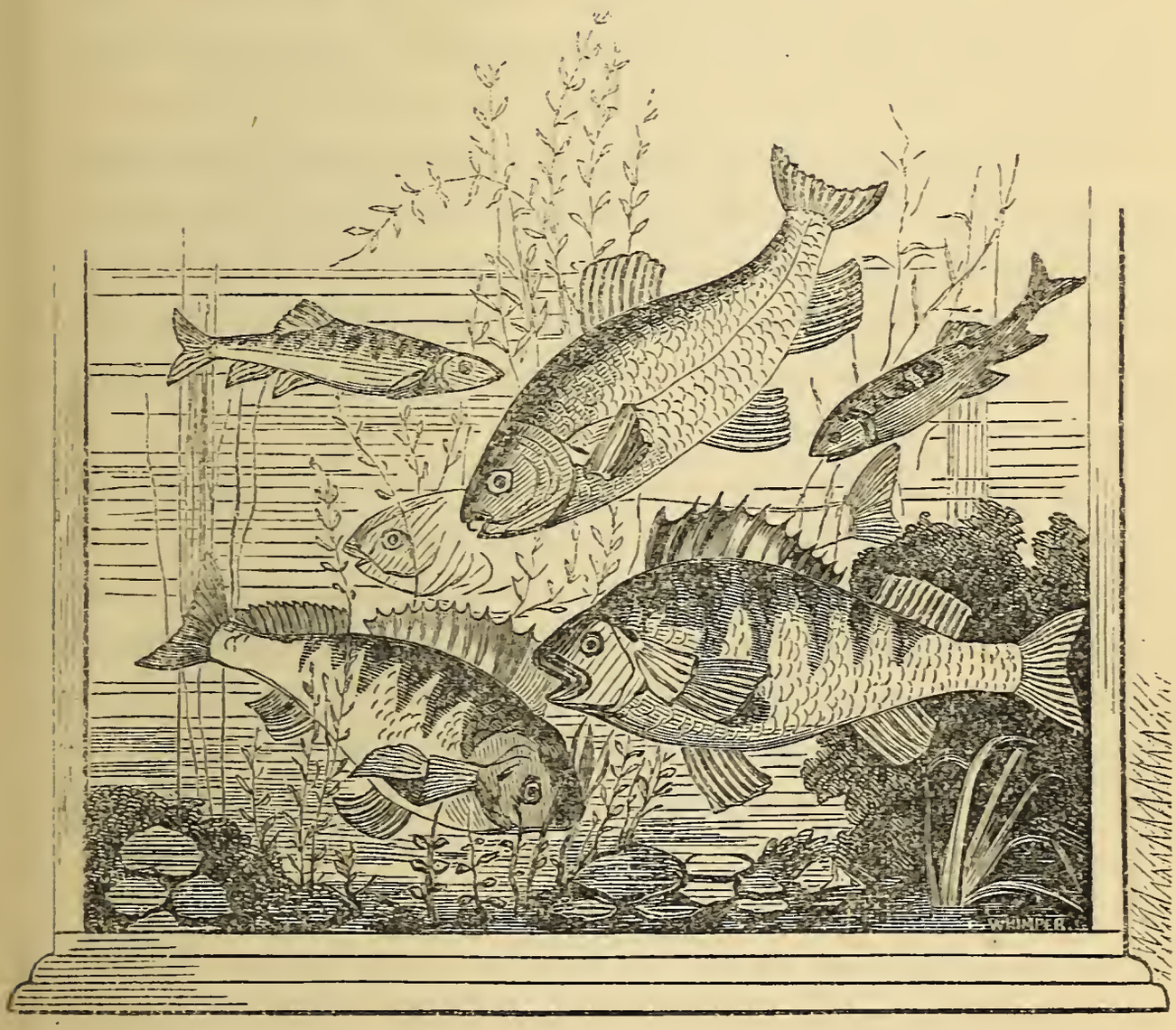
Tench. *C. Tinca.*—Is a quiet, shy fish, distinct in outline, and easily recognised; but, like the gudgeon, destitute of any highly attractive features. The tench is the most tenacious of life of any fish in the collection, and never shews signs of exhaustion by gulping air from the surface. Tench are easily tamed, and take great pleasure in nibbling their proprietor's fingers. Mine eat bread and cheese with me, and nibble my fingers playfully whenever I permit them. I have specimens now

that have occupied the same vessel a period of five years.

Barbel. *C. Barbus.*—A handsome but shy fish, furnished with barbules. The dorsal and caudal fins are very symmetrically shaped, and the lateral line arrests the eye when we contemplate his pleasing colours. If small newts, small carp, and minnows are kept in the same tank with barbel, they are likely to disappear one by one; for when all is quiet he makes his meal without seeking aid from the culinary art. They are not long-lived.

Loach. *C. barbatula.*—Is perhaps the most interesting fish in the tank, considered as an individual. With no attractive colours, and with an outline as straight and rigid as a piece of bark, he surprises you with his graceful motions as he hawks along the surface of the glass, propelled by the easy undulatory action of the caudal end of the spine. Towards dusk he wakes up from his day-light stupor, and commences his queer, but pretty gyrations; and, after gliding ghost-like all round the tank, suddenly drops down as if dead, and rests on any leaf or stone that may receive him, remaining motionless, and in any attitude—on his head, his tail, or his side—that the power of gravity may give him. Then, with an uneasy fidgetting, he flounders up again, and off he goes, as graceful as before, his pectoral fins spread out like samples of lace, looking as much like an eel with frills as it is possible to conceive. When ascending, his motion is so undulatory that he may easily be mistaken for a smooth newt, going up for a bubble. Nor is our interest in him lessened by his displays of individuality of character. He is a savage on a small scale. When he is quietly dozing, half-hidden among the sand and pebbles, throw in a small red worm, and, as soon as the water is tainted with the odour of this favourite

food, he is awake and on the search. A triton seizes the worm, and shakes it as a cat would a mouse. The loach hunts him down, snaps at him fiercely, and tears the worm from his mouth, and woe to any minor fish that attempts to remove it from those bearded jaws.



MINNOW, TENCH, AND PERCH.

He flounders from place to place, shaking the prey as he goes, and stirs up such a cloud from the bottom, that the beauty of the scene is spoiled for an hour; at the end of which time you will probably find him gorging the prog, half of which still protrudes from his mouth, while two or three hungry minnows loiter about, looking wistfully at what they dare not hope to obtain.

It is a pity the loach is so delicate; it shews signs of exhaustion sooner than any fish in the collection. If oxygen fails, it comes to the surface to gulp air, and at last rolls over on its back, and pants in a way that is very painful to witness. Removed to a pan, under a jet of water, it soon recovers; but if long confined in a vessel the least overstocked, especially in warm weather, finishes his career by convulsive gaspings at the surface.

A curious species of loach, known as the spine loach, is met with occasionally in Wiltshire, in the Trent, near Nottingham, and in some of the tributaries of the Cam. Mr. Yarrell describes it; but as I have not yet had the good fortune to possess a living specimen, I can only refer to it casually.

Chub. *C. cephalus.*—The chub is not a good Aquarium fish. It is shy, but grows familiar under good treatment, and will live a long time in a large vessel where there are few occupants, but soon perishes in a crowded vessel. Insects sooner attract it than any other food. Mr. Jesse says, that those in his vivarium throw off all reserve at the sight of a cockchafer, which they devour with eagerness.

Amphibia.

The resemblance of the water lizards to the true reptiles is not sufficient to give them a place under that head in classification. In the first period of their lives their respiration assimilates to that of fishes, and they are strictly aquatic; but in a second stage they become air-breathing animals, and hence when kept in tanks must have accommodation in the shape of rock-work above the surface, or floating pieces of cork or pumice, to pass as much of their time as they please out of water. The most remunerative way to deal with them is to procure

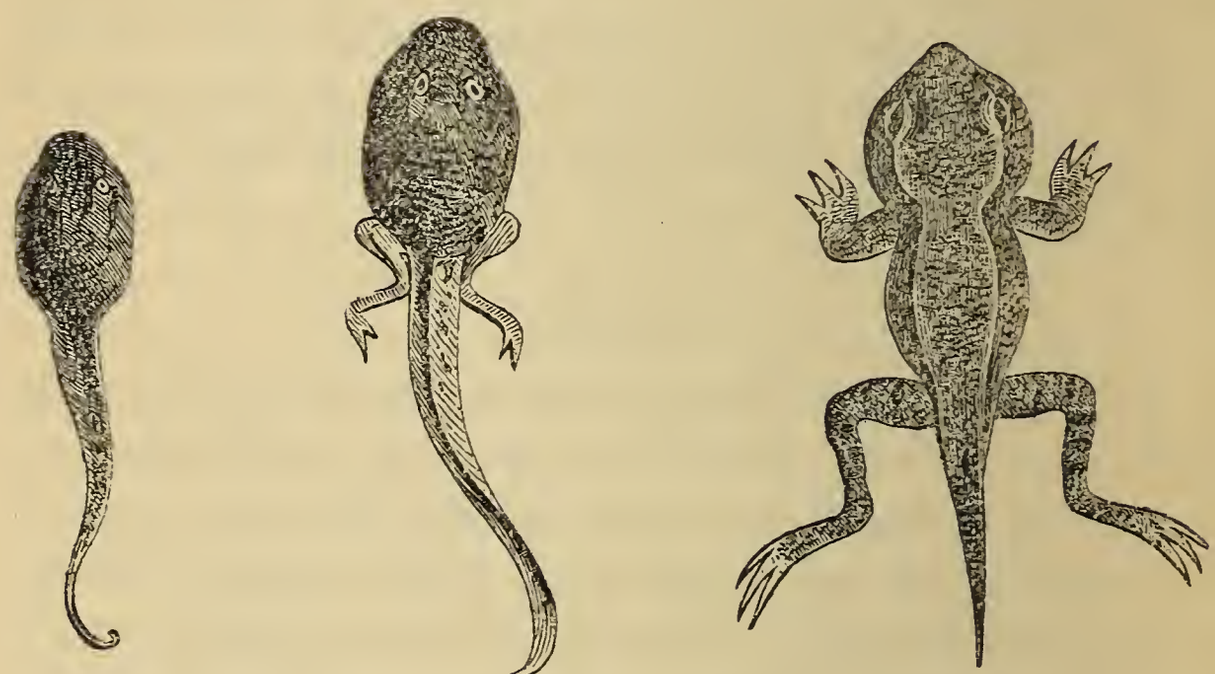
either ova or tadpoles, and watch them through their transformations, and then let them have their liberty. If kept as tenants of the tank, when arrived at maturity escape must be prevented by a covering of gauze, or if the cover is of glass, there must be several openings for air, and a good space between the surface of the water and the glass, to allow room for their sportive actions. The newts are really ornamental, but frogs are not, and had better be allowed their liberty when their transformation is at an end. The only orders of Amphibia that concern us are *Anoura*—the frogs and toads, and *Urodela*—the newt tribe, in which the tadpole changes are of the same kind as the frog, but do not proceed to the same extent.

Anoura.

The Frog.—The *Ranidæ* or true frogs, and the *Bufoidæ* or toad tribe, contribute, whether in the larva or perfect form, some very lively, entertaining, and instructive specimens, and indeed but little progress can be made in the study of Zoology without a patient study of their history. During the spring and summer the brooks abound with what boys call "loggerheads," or tadpoles; these are the larva of the frog. They may be caught easily, and preserved in jars of growing weed, for observation of their development. I have now (August 18th.,) several specimens of *Bufoidæ*, in which even the first stage of metamorphosis has not commenced, though, since June, some hundreds of toads and frogs have attained completeness in my vessels, many of which are now inmates of the garden, some of them exceedingly tame.

In the egg state we find abundance, during April, in every pond and brook, adhering in gelatinous masses to the under leaves of aquatic plants. The eggs gradually

acquire a dark tint, and at last the young "tads" emerge, and begin their quiet existence in this first rudimental form. In this state they are very lively in their motions, the eyes are very distinctly visible, and the mouth is placed, as it were, on the breast. They are not wholly herbivorous; for though they nibble the fronds of *Riccia* and threads of *Conferva*, they do not scruple to eat their dead kindred, and half a dozen may be seen engaged upon the carcase of a defunct brother. In this stage the



gills form a fine microscopic object. As the "tad" increases in bulk, the hinder part of the body swells, and at last the budding of the hind legs may be distinctly seen. These at last acquire some degree of completeness, and then the other pair of legs sprout in a similar manner, and the tail begins to shrink rapidly as the general bulk of the reptile increases. The gills now rapidly disappear, and the body grows at the expense of the tail, and before the latter appendage is completely extinguished, the juvenile *Ranus* takes his first dose of atmospheric air, by mounting a leaf of frog-bit or a slice of cork. He now leads an amphibious life, and at last quits the water

altogether, climbs up the glass side of the tank or jar, and escapes, unless confined by a lid of wire net or gauze. But he is now a true frog, delicately moulded, agile in his movements, very clever in jumping and swimming—his tadpole tail entirely absorbed, and his whole system metamorphosed. If he interested us before, he is still more interesting now, for in the structure and economy of his frame Nature reveals phenomena typical of animal life in all its orders and gradations. Hence the frog is the victim of the philosopher; he suffers spasm under the galvanic wire, blindness under the glare of the microscope lamp, tetanus through being dosed with strychnine, and innumerable other agonies in which operators detect analogies that throw a light on the fundamentals of animal life, and that even aid in the explanation of the subtle organism of man himself.



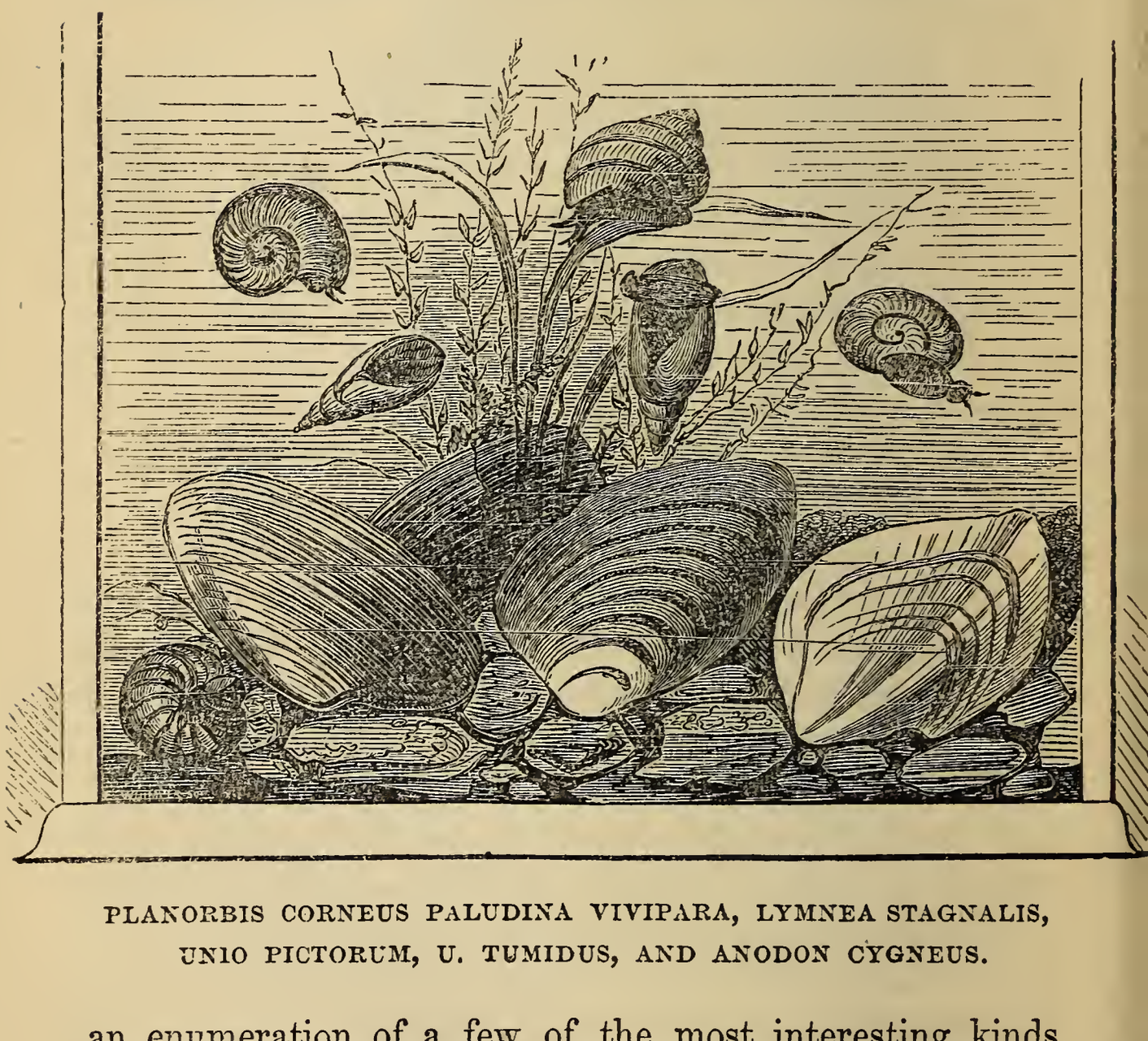
Urodela.

The Newts comprise only two species, but there are probably some permanent varieties of each. The smooth newt, *(Lissotriton punctatus,)* is beautifully spotted, and in spring the male assumes a gay attire, and is readily distinguishable by his fine crest, which extends in graceful wavy folds to the extremity of the tail. The great newt, *(Triton cristatus,)* is larger and more handsome than the preceding, and during the breeding season the male wears a resplendent crest. They will live for almost any length of time out of water, as I know from specimens which have escaped from my tanks being found many months after in a dry cellar, and the identity of which could be proved by their having partly reproduced their

tails, which had been amputated a year before. That their tails are reproduced after being removed is a settled point, so I hope the mention of the fact will not induce any reader to perform a cruel experiment, in order to discover that which is already known.

MOLLUSCA.

Having already enlarged upon the habits and uses of mollusks, there is no occasion here for anything beyond



PLANORBIS CORNEUS PALUDINA VIVIPARA, LYMNEA STAGNALIS, UNIO PICTORUM, U. TUMIDUS, AND ANODON CYGNEUS.

an enumeration of a few of the most interesting kinds. Those most worth seeking, arranged in the order of their suitability, are as follow:—

Planorbius corneus, the horny coil-shell; *P. carinatus*,

the keeled coil-shell; *Physa fontinalis*, stream bubble shell; *Lymnea stagnalis*, pond snail; *L. auricularis*, eared pond snail; *Paludina vivipara*, viviparous paludina; *Bithinia tentacula*, tentacled Bithinia; *Dreissina polymorpha*, many-shaped Dreissina, occurs usually as a parasite on *Unio pictorum*, the duck mussel; and *U. margaratifera; Anodon cygneus*, swan mussel; *Cyclas corneum; Ancylus fluviatilis*, fresh-water limpet. The two last should be kept in separate vessels, as they are likely to die, and cause a most obnoxious putrescence, which will surely cause many other deaths, unless the cause of annoyance be speedily removed. The mussels will live for years in well-managed tanks, but if one dies there is an immediate liberation of sulphurretted hydrogen, which poisons the whole of the water. While in health they act as filterers by the mechanism of their siphons and ciliated gills, and thus strain off from the water objectionable matters held in suspension.

CHAPTER VIII.

CABINET AQUARIA.

THE Aquarium had scarcely taken its place among the resources for pleasurable recreation, and scientific study, when the field of culture extended itself, and every variety of minute life found in the waters, came to have its share of attention for the general profit and delight of the studious. The ordinary tank was found insufficient for the wants of the aquarian, and wherever a large vessel was to be seen stocked with fresh-water fishes or marine objects, a collection of small jars, phials, or show-glasses, was pretty sure to be found also. In an Aquarium we may group together many dissimilar objects; but it must be evident to the most superficial observer, that when immersed in a large body of water with other creatures, many objects are ill-placed for examination, especially if we use the microscope. Hence, where the study is pursued with any degree of ardour, some special arrangements are necessary to enable us to keep in a healthy state, and in a way that admits of close scrutiny at any moment, such of the smaller aquatic objects as most commend themselves for beauty or scientific interest. Many beginners, unable to resist the temptation of a jar of beetles, or a collection of larva, and having no other means of keeping them, have placed them in the tank to mingle with the stock of finny creatures, and have thereby either lost the better part of the collection, or

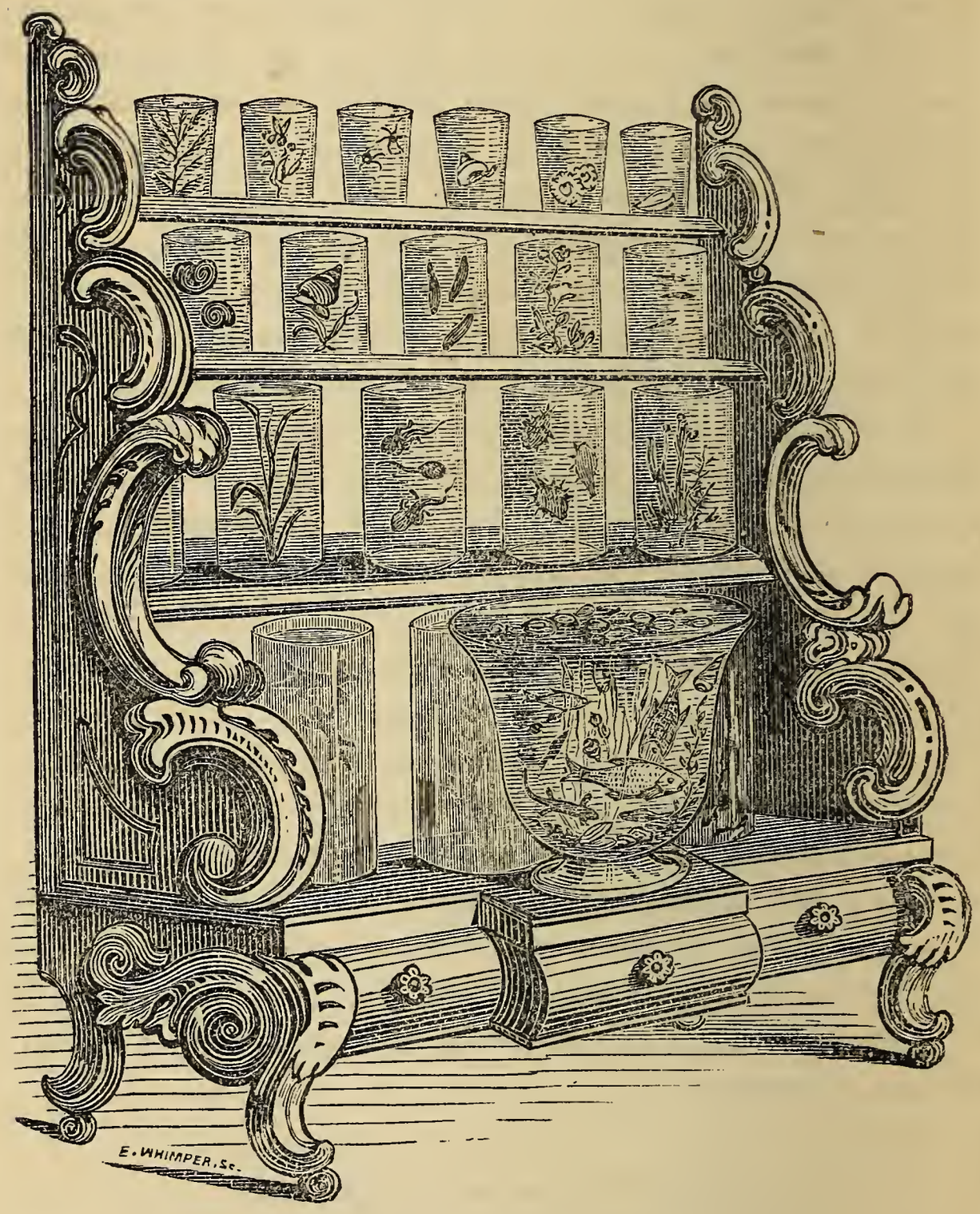
have been compelled to break up the stock and begin anew. A few species of water beetles and aquatic larvæ may be safely preserved in an Aquarium; but an Aquarium is by no means the best place for them, if we wish to study their habits closely, or investigate their mechanism and economy by the aid of lenses: all insects, many mollusks, larva, and other small objects, should be kept apart, and collections of such objects are what I understand by the term Cabinet Aquaria. It is true that all Aquaria are Water Cabinets, and all Water Cabinets Aquaria, yet the distinction seems necessary in order to confine within certain understood limits the range of the Aquarium as a domestic recreation.

To the genuine student, there is really more for remunerative study in such a collection than can be found in the Aquarium, though the tank, whether river or marine, will always prove most attractive as an ornament, and because it requires less care and study, will be pretty sure to retain the greatest number of admirers. But the Aquarium and the Cabinet are to a certain extent distinct; they cannot be combined in the same vessel, and, though a Water Cabinet is but another form, or rather a series of separate and smaller aquaria, the uses and economies of each are in a great measure distinct. It is possible to cultivate either without the other, though we should generally expect to find them in company, the Cabinet being a growth or extension of the Aquarium.

CONSTRUCTION OF A CABINET.

Ingenuity, under the control of circumstances, will devise many modes of preserving the smaller specimens of aquatic life, and I shall here describe a plan which I think would be found most generally useful, partic-

ularly as it may have a very simple form, and be produced for a very trifling outlay; or may be elaborated into a noble piece of furniture for the adornment of an elegantly-furnished room.



CABINET AQUARIUM.

The woodcut represents a series of shelves fitted into a carved frame-work, the lower portion of which forms a table with drawers. My own cabinet, which is a

simple affair of stained deal, is made after the model of the one here represented, but without ornament of any kind; and if I describe its measurements, it may serve as a guide to any who may desire to have one constructed of a similar pattern, though, as a matter of course, the plan admits of endless modifications to suit the means of the student, or the position in which such a cabinet is to be placed.

The table measures nineteen inches from back to front across the centre drawer; and from back to front across the two side drawers, twelve inches. On this is placed a row of seven-inch cylindrical glasses of clear flint glass, and in the centre behind the jars, stands a twelve-inch bell-glass Aquarium, to be stocked with choice fishes or superfluous cabinet specimens. The first shelf has a breadth of eight inches to receive a row of six-inch glasses; the second shelf a breadth of five inches, and the jars upon it measure four inches in diameter. The top shelf is only three and a half inches wide, and the glasses on it measure three inches across the top, and two and a half at the base; the jars of this size, in my own collection, are of a tapering form, half an inch narrower at the bottom than at the top, though I am not aware whether such is the usual form of the small vessels. The entire frame-work has a breadth of about thirty-two inches, and a height from the floor of the room to the level of the top shelf, of about sixty-six inches.

The breadth and height of the window in which the cabinet is to be placed, must have the first consideration with any who may intend to construct such a piece of furniture; the respective sizes of the vessels must be an after-consideration, because, unless the whole be so adapted, as that it shall enjoy a full share of uninterrupted daylight, very little progress can be effected,

especially if the growth of the more delicate forms of aquatic vegetation be attempted.

In the absence of a properly-constructed set of shelves, a few plain ones may be fitted up in a window. A single strip of deal, on brackets, would afford room for a dozen jars, and in these, by judicious grouping, specimens of from fifty to a hundred kinds could be kept, whether for observation by the naked eye, or the microscope.

GLASSES.

In common with many aquarians I used phials and confectioners' show-glasses for a considerable length of time; but to preserve the uniformity of the collection, I should recommend cylindrical glasses of flint glass of the form represented in the engraving. Chancing to unearth a number of such glasses, at the warehouse of the Messrs. Phillips, of Bishopsgate Street, I have since abolished the *olla podrida* of acid bottles and phials, with which I had previously been content, and now use no other kinds, and I think their strength and clearness of colour must commend them to the student, as the best that can be had for the purpose. The cost of them is a shilling a pound, though common show-glasses may be had at ninepence a pound. If there is much dust in the room, where the cabinet stands, a strip of green gauze might be stretched on light cane frames over each row of glasses. Taller jars for *Vallisneria* and *Nitella* will also be found useful and highly ornamental.

The jars are intended for the reception of separate or grouped species, and the bell-glass may be an ordinary Aquarium or a receptacle for the *omnium gatherum* of general collecting, such as minute aquatic plants, beetles of various species, diving spiders, water worms, and

mites, larva of beetles and flies, tadpoles in progress of transformation, mollusks of choice kinds, and spawn of all kinds, removed from the tanks. The bell-glass serves for a miscellaneous assemblage of duplicates of all kinds, such as water weeds for the renewal of tanks, tadpoles, leeches, whirlwigs, mollusks, crustacea, and infusoria for the microscope. Species that do not agree, may be introduced to the bell-glass for the sake of teaching us the nature and incidents of the strife maintained in the great world out of doors; the battle may there have its way, and we may study destruction with as much profit as we may the momentary creation by which the system of nature is maintained in its completeness. In fact, the bell-glass is a reservoir into which we may dip for almost anything we want to fill up vacancies in the jars, and in the proper tanks, and to which we may consign the superfluities of a day's collecting; having first assorted, and set apart such as are wanted for separate observation and study.

CHAPTER IX.

COLLECTING AND ARRANGING SPECIMENS.



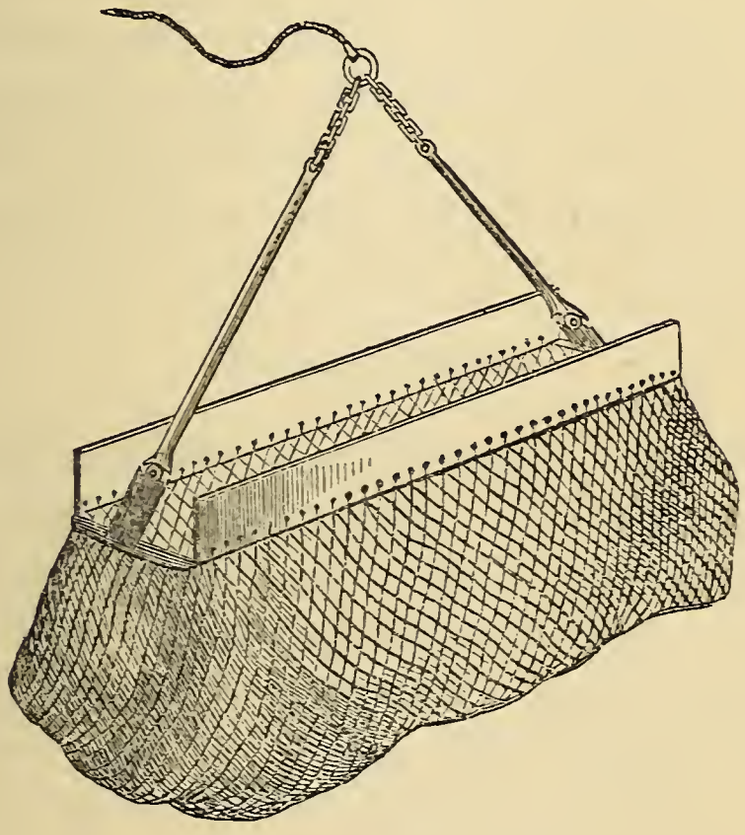
MOST of the ordinary productions of ponds and brooks may be purchased of the dealers, especially beetles, larger kinds of larvæ, water spiders, and tadpoles; but very little progress can be made in the study of this branch of natural history without personal visits to the fishing grounds. Mr. Lloyd catalogues a large number, and labours assiduously through his numerous agents, to keep the stock at all seasons as complete as possible.

An hour spent in dragging a brook or pond, will do more towards stocking a cabinet with wonders than a hundred purchases. To the pleasure of an excursion is added the intellectual profit of learning the nature of the haunts, and many of the habits of the creatures obtained; every haul of the net will bring forth from the oozy bottom an immense variety of the most curious kinds of life.

IMPLEMENTS FOR COLLECTING.

Nets, for the purpose, are easily obtainable. At least, two kinds will be necessary, namely, a small hand-net attached to a short rod, or made to slip on a common walking-stick, and a larger one for a long rod, or for

hauling with a line. The small net should be of a fine mesh, and for convenience of carriage, may be fitted on a jointed ring of brass, so as to fold together. The large net need not be very fine in the mesh, but it should be very strong, both in the texture and the fittings, and should be lined inside with muslin so as to prevent the escape of the smallest game. Every variety of pond and drag-nets may be obtained of the dealers in fishing-tackle, at prices varying from one to five or six shillings,



and of a quality that may be depended on for serviceableness. Ball's Dredge, as manufactured by Mr. Lloyd, and here figured, is the best of all for its lightness and portability. Some water-cord, a jointed rod or walking-stick, and a few earthen jars, or live-bait cans, make up the stock of implements, the whole of which, with the exception of rods, may be packed into a basket in which suitable divisions are made, and transported easily. Living in the neighbourhood of many prolific brooks and ponds, I have very little experience in the carriage of

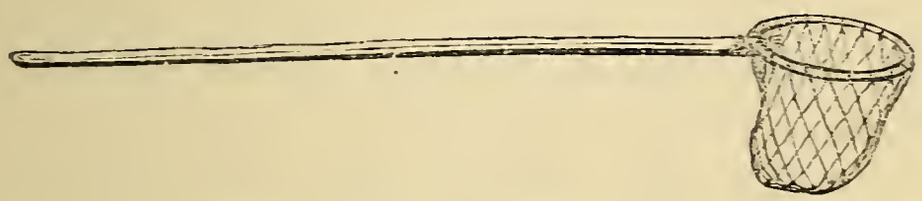
specimens, and, indeed, seldom use more than a single jar, and a single net at one time; but I should suggest to those who have to travel a distance for the pleasure of beetle fishing, to provide themselves with a basket or box, made after the fashion of the baskets in which bottles are sent out by vintners, the divisions being fitted with stone jars; and one division left the whole length of the basket, for nets, scissors, a pair of forceps, and a few small phials. Each vessel should have a lid of perforated zinc, to prevent the escape of objects during transit; the jolting of a railway train or coach might otherwise waste the contents, The stone jar used for the purpose, should have a cord attached round the rim of each for convenient handling at the brook side.

POND FISHING.

Every variety of stream or stagnant pond may be fished to advantage; but the specimens obtained from clear running brooks will, in general, differ greatly in character from those which the drag-net brings from a dark still pool. Ponds which have formed in gravel pits, are generally well stocked with newts, mollusks, and tadpoles; but for the varieties of the beetle family, old ponds in meadows, and which are the resorts of cattle, are the best; ditches and rank brooks are the usual haunts of caddis worms, diving spiders, polypes, and the more beautiful varieties of water-bugs; but every locality has its special attractions only to be learnt by experience.

Supposing that you have made a halt beside a pleasantly shaded brook, with hedge sparrows, robins, and black-caps warbling about you. You prepare by selecting a suitable spot free from brushwood, and where the edge of the water may be reached without danger. The first thing to be done is, to fill a few jars with clear water,

and to throw into each a few strips of any common water weed, of which *Callitriche* is always the best, and most generally attainable. If the water is very foul it will be better to travel a little distance for a supply, because the specimens are wanted as cleanly as possible, and if thrown into clean water when caught, their own motions will tend to cleanse them, and fit them for the glass jars at home. The shore should be fished first, and the operation should be conducted with as much quiet as possible; any disturbances will be sure to drive away many of the livelier creatures. Take a small net attached to a walking-stick or short rod, and thrust it out from you as far



as possible over the water; then quickly dip and draw it towards you, and land it at your feet at some little distance from the edge of the water. Sort out the contents of the haul into separate jars, though, as you cannot have as many jars as the kinds which the net will bring up, a little judicious grouping will be necessary. Spawn of all kinds may be placed together in the same jar with mollusks, tadpoles, caddis worms, and colymbetes; most beetles must be kept by themselves, on account of their voracity, as must also the several kinds of carnivorous larvæ, such as those of the *Dyticus*, and the dragon-fly, and water-worms of the genus *Nais*.

When the sides have been well fished, the deeper water may be operated on by means of the drag-net, and the produce disposed of in the same way.

On arriving home, sort over the jars *seriatim*, and dispose of the specimens according to the capacity and

arrangement of your cabinet. The glass jars should be each furnished with a few tufts of some growing weeds, and with clear water. Some of the specimens will require to be washed to remove offensive matter, and some few will need a bottom of small pebbles, and a jar nearly filled with healthy vegetation. *Anacharis*, *Myriophyllum*, *Nitella*, *Chara*, *Riccia*, and choice *Confervoids*, are the best for the cabinet, on account of the limited space in which they must be kept, and the elegance they impart to the collection. In the larger jars it would be well to keep some tufts of *Vallisneria* in order to propagate it to supply vacancies in the tanks. When the stock has been housed in the cabinet, whatever is left may be transferred to the bell-glass for further examination. It would be better not to wash or disturb the refuse weed and sediment of the collecting jars, but to throw the whole into the vase. After a few hours it will settle down, and a lens will assist in the detection of whatever curiosities may swarm out of the refuse weed. Objects for the compound microscope may in this way be obtained and preserved in plenty.

CHAPTER X.

CABINET STOCK.



HAVE already indicated some of the varieties best suited for the cabinet, but will here briefly enumerate those which form the leading features of attraction, leaving the development of the collection to the perseverance of the student. The great division of *Coleoptera* will furnish by far the largest number of showy species, all of them interesting and lively creatures, many of them possessed of great beauty. The ravenous *Dyticus marginalis* and *dimidiatus*, with their strong hooked claws, and brightly bronzed elytra; and the pretty, docile, and harmless *Colymbetes*, with its shining silver breast-plate, and jet black limbs and elytra, must take the first place among the beetles for beauty of form and colour. The large, harmless *Hydrous piceus*, the lively *Notonecta*, *Gyrinus*, and *Nepa*, are essential to the collection.

Among the larva, those of the Caddis fly should be kept in abundance, on account of the amusement afforded by their strange habits and their remarkable metamorphoses. Larva of the *Dyticus*, known as the Water Tiger, of the Dragon-fly, the gnat, the Mayfly, and of the two-winged fly, *Stratiomys Chamæleon*, the common blood-worm, which is the larva of the *Chironomus plumosus*, a very pretty gnat, with feathered antennæ; and the telescope-tailed grubs of *Helophilus pendulus*, which, in its larva form, is one of the most curious examples

in the cabinet, and, in its imago, is frequently mistaken for the honey-bee.

The drag-net will also bring out many curious water-



DIVING SPIDER AND NESTS.

mites, than which there can be no more interesting subjects for the microscope, or prettier objects for ordinary observation. While writing this, I have before

me several specimens of the beautiful mites, *Hydrachna geographica* and *abstergens* (Müller,) in a jar of *Nitella;* they are ever in action, treading the water as if it were air, with a kind of motion that cannot be termed swimming, but rather a walking or dancing, maintained with the greatest ease at any level, or at the bottom of the vessel. Another, and much more showy one, is the bright carmine-coloured mite *Limnochares holosericea* (Latreille,) of which I find abundance in a neighbouring brook. Its pretty, spidery motions, and vivid colouring, render a jar, containing a dozen specimens, very attractive to the eye of a student of nature.

The Diving Spiders are amusing, and should be kept in plenty of large jars, well stocked with healthy weed; and from time to time be fed with blood-worms; the curious Raft Spider may also be preserved in a shallow vessel, closely covered with gauze. Aquatic Spiders are most abundant in clear brooks and ditches near rivers; the small tributaries of the Lea, and the dykes that abound in the marshes at Tottenham, supply me with specimens whenever I seek them.

Among the water-worms most easily obtained, the hair-like *Gordius aquaticus* (Linnæus,) and the curiously formed *Nais*, may be recommended as curious and interesting. The latter requires a bottom of sand in which to burrow, and should be covered with only a few inches of water. When it takes to its new home, it plunges its body into the sand or mud, and extends its telescope-tail upwards to the surface for air, adapting its length to the depth of the water.

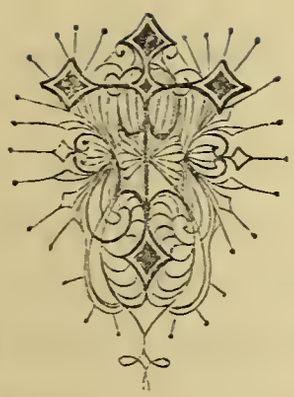
The generation and development of reptilia and mollusca may be better studied by the use of jars for the specimens, than by their immersion in the Aquarium. Tadpoles, the larva of newts, and the spawn of mollusks, may be preserved in the cabinet for purposes of study,

much better than in the tank; each species being separate in a bright and portable vessel, every minute change can be observed, and a lens applied at any time, or the specimens removed for close inspection without difficulty. I find it a good practise to remove any spawn, which may be deposited on the large vessels, to the small jars on my shelves. There the little *Lymnea* and *Planorbis* are developed in hundreds, without molestation; and if increase of *Paludina vivipara* be required, a jar is at once converted into a breeding tank by throwing a couple into it, with a bunch of *Callitriche*, and any vegetable waste from the tanks. In the Aquarium, the young mollusks are devoured almost as soon as they are born; and the pleasing spectacle of their increase, coming forth from the gelatinous mass in hundreds, like minute beads of gold, is lost without the aid of the cabinet in which to rear them. The young of most species of univalve mollusks are vagrant in their habits, and the jars in which spawn is hatched should be closely covered with perforated card or gauze, fitting closely by means of India-rubber rings.

Since it is unnecessary in this work to give a classified history of the several creatures that may be kept in water cabinets, I shall devote the remainder of the space at my command to notices of a few of the most attractive and best known species, and to a few hints on the general management of the cabinet.

CHAPTER XI.

LARVA.



THE great class of insects comprises many remarkable and diverse forms among the five hundred and sixty thousand species which Dr. Imhoff estimates to be now known to naturalists. Yet, various as they are, it is by no means impossible to define what are the distinctive features by which this class is separated from those which approach it in conformation and habits. A true insect has the body divided into three parts—the head, the thorax, and the abdomen. It has never more than six legs, and these are attached to the thorax. The segments of the body seldom exceed thirteen in number, one of which forms the head, three the thorax, and the remaining nine the abdomen. The possession of one or two pairs of wings gives them their prominent characteristic to the eye, but it is the successive metamorphoses that arrests universal attention, and calls forth the admiration and wonder of mankind. In the progress of an insect from the minute egg to its completed form, we see the most remarkable series of developments which animal life ever displays in all its endless procession of forms—the egg, the worm, the chrysalis, the fly—a strange unfolding, for the first time accurately observed by Swammerdam, who detected, under the wrinkled skin of the disgusting worm, the complete outline of the lovely butterfly.

This metempsychosis may be studied in its several strange details by the aid of the water cabinet. The first condition of the newly-hatched egg is that known as the grub, or caterpillar—scientifically called the *larva*. The larva generally bears no earthly resemblance to the *imago*, or perfect insect, into which it is to be hereafter developed, but leads a life of sensual enjoyment—it eats, eats! it is gluttony concentrated in type and act. It changes its skin several times, slips one coat off and acquires a new one; growing, and eating, and changing garments, till, like man himself, it seeks a temporary tomb, from which it is to soar to the skies like a soul liberated. This second form is popularly known as the chrysalis, or aurelia, scientifically called the *pupa*. In this form the insect remains in a state of complete or partial torpidity for a few days, weeks, or months, according to the particular species.

The day of its deliverance arrives, its bonds burst, and it comes forth "a thing of beauty" to sport in sunbeams, and, for but a brief season, lead a life of joy—

> "Fluttering round the jasmine stems,
> Like winged flowers or flying gems."

But beauty of the high poetic kind is not the inheritance of every member of the class insecta; and the water cabinet presents us with many that have but analogical resemblances to the typical structure of the moth or the fly, though the naturalist finds beauty in a beetle, and points of profound interest in a maggot or grub.

Since larvæ are distributed through at least three elements, being, according to the species, inhabitants of earth, air, and water, the breathing-apparatus arrests our attention, as constituting a distinct feature in the anatomy of the insect. A caterpillar may be regarded as all

stomach, and the cravings of this immense digesting-tube easily account for the voracity of larva of all kinds. In the larger animals, the food is elaborated into blood, and brought to the lungs to be oxygenated by means of contact with the air, but the insect does not breathe at the mouth, but at the other end, or by means of tubes arranged along the sides of the body. In a caterpillar there are usually eighteen of these tubes, the orifices of which may be seen in action. These tubes all run into two larger lateral tubes, or wind-pipes, arranged one on each side of the body; and from these lateral tubes innumerable smaller ones diverge, and convey air to the vessels in which the digested food is contained, and thus supply it with oxygen. Swammerdam was the first who successfully anatomized this class of animals, and to him we are indebted for the microscopic anatomy of grubs, and a revelation of their inner economy generally.

The Dragon-fly, *Libellulidæ* (Leach,) a well-known summer beauty—the mere mention of which is always sufficient to set one's heart beating for rustic coolness, and the hushed music of the beechen shades—is, in its larva form, an interesting object for the cabinet. Between the larva and the imago of this insect, the difference is striking indeed; as a lady, not addicted to scientific studies, once characterised the larva—using Pope's lines—as,

> "A monster of such hideous mien,
> That to be hated needs but to be seen."

But the gauze-winged and gaily-coloured fly merits all the praise bestowed upon it by the French, who call them *Demoiselles*, so light, fairy-like, and visionary are its form and movements. Scientific writers have applied many descriptive names to it, such as *Calepteryx* (pretty

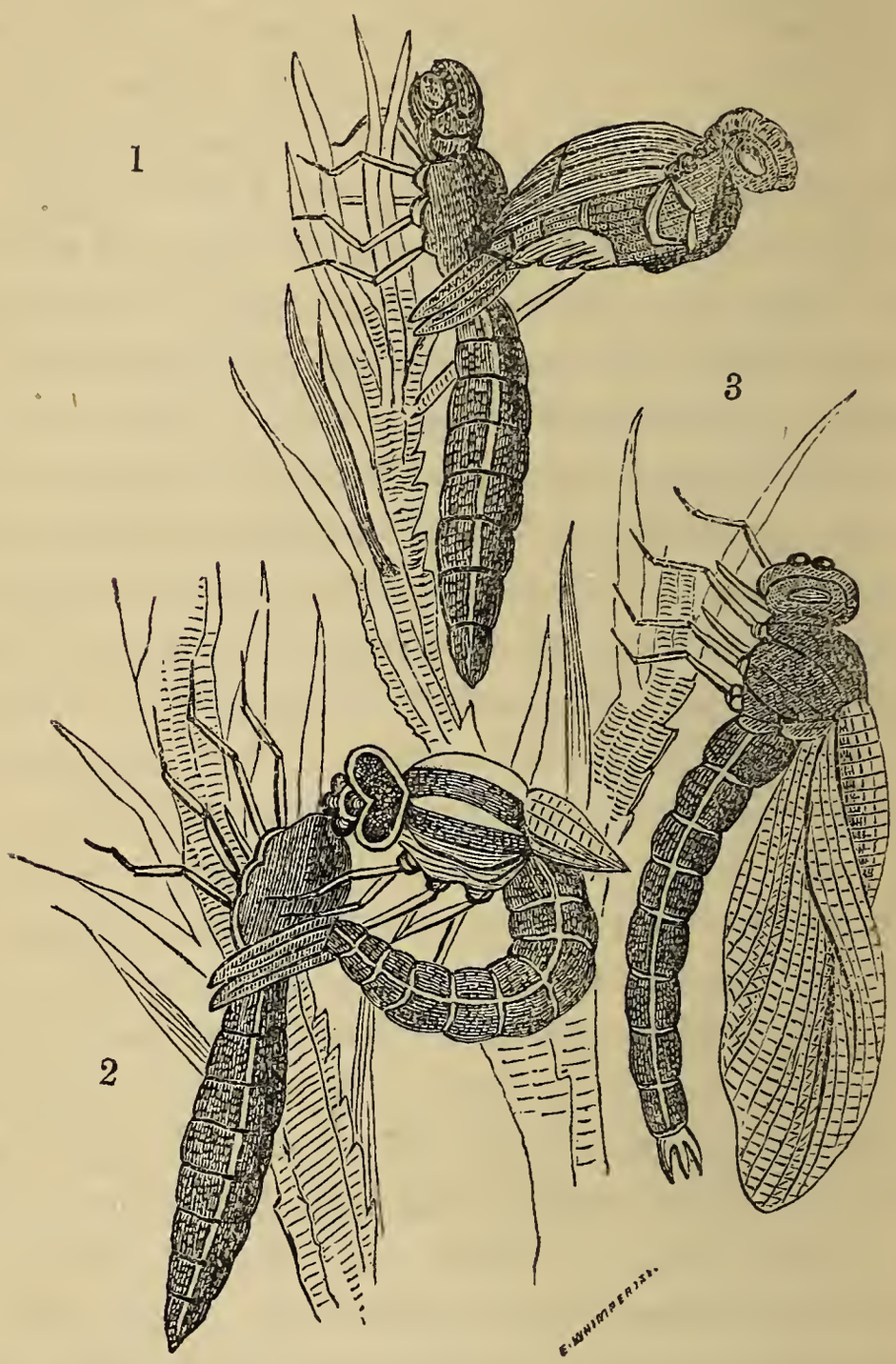
wing,) *Puella* (girl,) *Sponsa* (bride,) and *Virgo* (virgin.) The larva of the dragon-fly exhibits, in a very striking manner, the mode of respiration in aquatic insects. It is not an active creature; for though it has six legs, it seldom uses these except in the capture of prey; its locomotion is chiefly performed by the tail in the action of breathing. When thrown into a jar with some fragments of weed and a few light chips, these will be seen to be drawn towards the tail of the creature, by the current occasioned by the absorption of water; and then again driven off, with considerable force, as the water is again ejected. The quantity drawn into the body by this hydrostatic action must be considerable, since the dimensions of the larva regularly change with the breathing action, the body becoming collapsed when the stream is ejected, and again swelled out with the suction that follows. If it be thrown into water, tinged with cochineal, and then quickly removed again into clear water, the coloured stream will be seen to be projected several inches, and with force sufficient to propel the creature forward by a series of successive jerks.

Beside the act of breathing, then, this anal pump has locomotive uses; and it also aids the creature in obtaining food by drawing minute creatures towards it, in a manner similar to those animals which are furnished with cilia.

But the microscope reveals a still more curious fact in the anatomy of this larva, which has been most faithfully described by Kirby and Spence. The under lip, when closed, entirely conceals the mouth, and it not only retains, but actually seizes, the animal's prey, by means of a very singular pair of jaws with which it is furnished. Conceive your upper lip (to have recourse, like Reaumur, on another occasion, to such a comparison) to be horny instead of fleshy, and to be

elongated perpendicularly downward, so as to wrap over your chin, and extend to its bottom—that this elongation is there expanded into a triangular convex plate, attached to it by a joint, so as to bend upwards again and fold over the face as high as the nose, concealing not only the chin and the first-mentioned elongations, but the mouth and part of the cheeks. Conceive, moreover, that to the end of this last-mentioned plate are fixed two other convex ones, so broad as to cover the whole nose and temples—that these can open at pleasure, transversely, like a pair of jaws, so as to expose the nose and mouth, and that their inner edges, where they meet, are cut into numerous sharp teeth, or spines, or armed with one or more long sharp claws—you will have as accurate an idea as my powers of description can give, of the strange formation of the under lip in the larva of *Libellulina*, which conceals the mouth and face, precisely as I have supposed a similar construction of lip would do yours. You will probably admit that your own visage would present an appearance not very engaging, while concealed by such a mask; but it would strike still more awe into the spectators, were they to see you first open the two upper jaw plates, which would project from the temples like the blinders of a horse; and next, having, by means of the joint of your chin, let down the whole apparatus and uncovered your face, employ them in seizing any food that presented itself, and conveying it to your mouth. Yet this procedure is that adopted by the larvæ of the dragon-fly, provided with this strange organ. While it is at rest, it applies close to and covers the face. When the insects would make use of it, they unfold it like an arm, catch the prey at which they aim, by means of the mandibuliform plates, and then partly refold it, so as to hold the prey to the mouth, in a convenient

position for the operation of the two pairs of jaws with which they are provided. The form of this masked



TRANSFORMATION OF THE DRAGON-FLY.

1.--The Fly just emerging. 2.--The Fly nearly free, and forming an arch. 3.--The Fly liberated, and with its body bent to hasten the drying of the wings.

jaw is represented, but not very clearly, in Rennie's "Insect Transformations," page 164.

When its season of larva life is over, it retires to

the bottom of the vessel to repose, and becomes a pupa. When the crumpled form of the gaudy fly begins to expand within, and to knock at the door of its sepulchre, the pupa quits the watery element for ever, and betakes itself to the dry land, or to the slip of cork placed in the jar for its use. There the apparently painful process of its unfolding takes place, and the fly slowly emerges. The envelope bursts asunder, and the head of the lovely, but blood-thirsty damsel, emerges to the light. Next appear the legs, not in action, but gathered up to the breast, as if in spasm, and, for a time, the effort is suspended, and the helpless, half-formed beauty hangs back her head, as if languid with the exhaustion of pain. Once more she pants for freedom, sighing to sun herself in the blue ether, and another struggle is made. This time she clutches at the pupa case with a convulsive grasp, and drags forth the whole of her delicate body from the grave, and there remains motionless, still clinging to it, as if contemplating the baseness of her origin—for beauty is ever the offspring of the dust. She is free at last—but ah! how helpless. Her wings are damp, and closely folded, and would not yield to the wish for flight, even were she already possessed of the power to stir them into action. She is on the threshold of a new world—a creature born of the dust, just escaped from the dust; and now as we watch her wings dry and expand, away she goes—a thing of light and loveliness soaring heavenward. Like the mortal ark, out o which the spirit of man escapes, we may, without losing sight of the disparity of the subjects, speak of the chrysalis of the dragon-fly as—

"A worn-out fetter, which the soul
Has broken, and thrown away.

The Gnat—*Culex pipiens*, (Linnæus.)

In the operation of dragging, many curious larva are brought out, and the mud should be searched carefully



DRAGON-FLIES.

a. Virgin Dragon-fly, *Calepteryx Virgo*.
b. Green Dragon-fly, *Æshna varia*.

for them before washing the net for another cast. The larva of the gnat is one of the most interesting of these, and during summer may be obtained in hundreds if a little of the brook water be dipped to fill the jar with,

and a few light weeds thrown in to supply oxygen. These larva are the produce of eggs deposited in a curious manner.

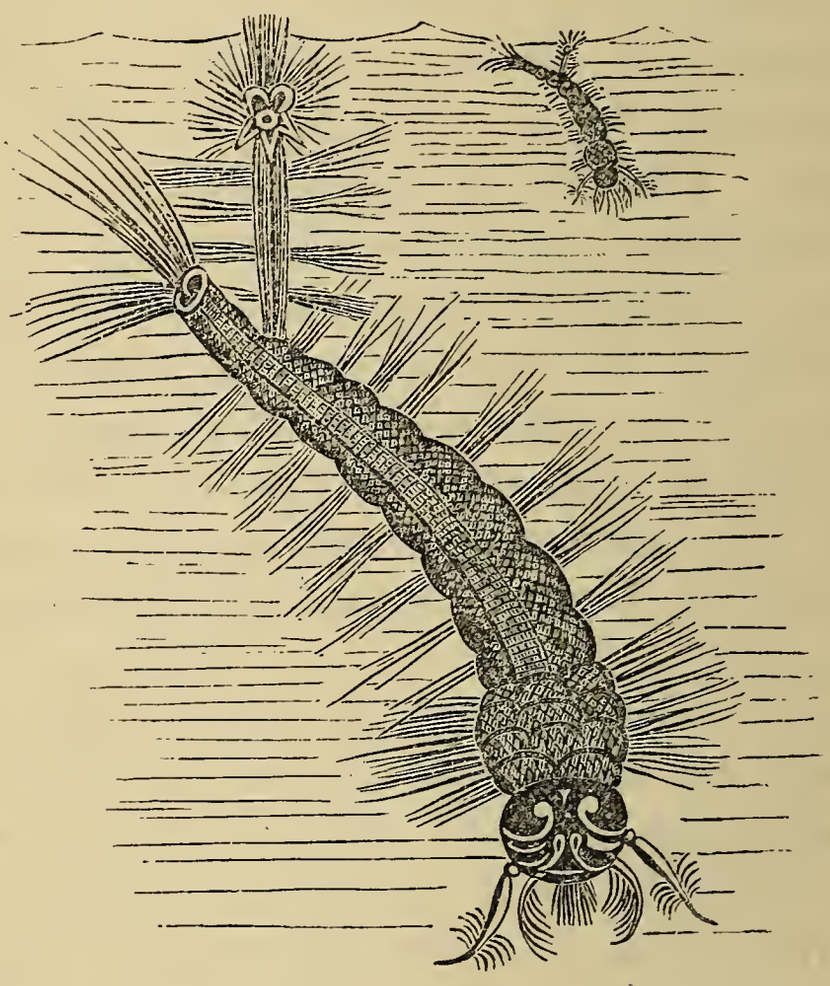
The gnats repair to the water soon after day-break, and commence an operation of a truly naval kind, such as would have delighted the savage heart of Peter the Great, could he have witnessed it in the midst of his dreams of achieving naval power. In fact, the mother gnats construct rafts of eggs, and each egg is added as a separate timber of the vessel, till a boat-like structure is produced. The skill as well as the necessity of the construction is well tested by the fact that each separate egg would of itself sink to the bottom, whereas being protruded one by one into the angle formed by the hind legs which serve as stocks for the future vessel, and successively glued to each other by the fluid which exudes with them, they gradually assume, under her guidance, a neat boat-like form of about three hundred minute pyramidal eggs.

"The most violent agitation," says Kirby, "cannot sink it, and what is more extraordinary, and a property still a desideratum in our life-boats, though hollow it never becomes filled with water, even though exposed."

The grubs at last come forth, and lead a very merry sort of life under the shadow of the sedges. Placed in the jars they appear at first sight like newly-hatched fry of fishes, but we soon detect the segments of their pellucid bodies, and, as might be expected in water larva, they breathe at the wrong end, and hence most of their merry movements are performed between the surface and the bottom; every time they descend they carry with them a minute bubble from the surface. Under a good lens the pretty creature changes its form considerably, and comes out in the pantomime style, with huge horns, goggle eyes, and starched frills of shaggy hair; but then

the tail becomes the object of attraction, and we watch the breathing action of the curious funnel which breaks away at an angle from the last segment of the body.

Swammerdam first observed that the breathing tube and tail are both anointed with oil, and that if the larva is handled roughly the oil is removed, and the grub "can

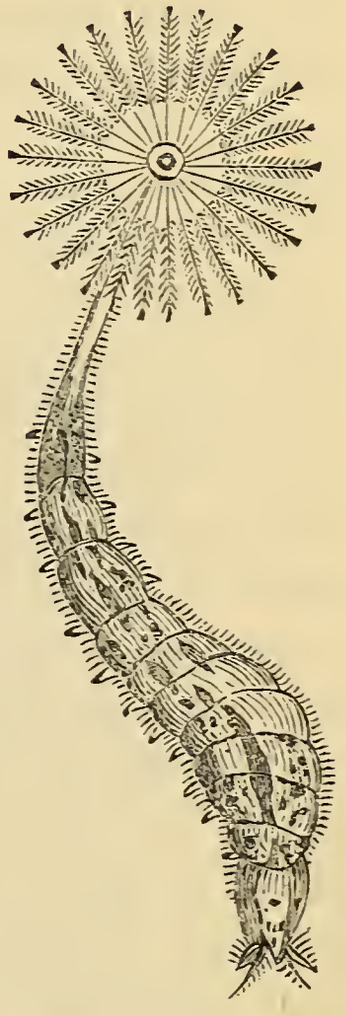


LARVA OF THE GNAT, (NATURAL SIZE AND MAGNIFIED.)

no longer suspend itself on the surface of the water. I have, on these occasions, observed it put its tail in its mouth, and afterwards draw it back, as a waterfowl will draw its feathers through its bill to prepare them for resisting water." I have now (July) some thousands of the larva of this and other species of gnats, and they are the most lively creatures in my collection. The flies come off in large numbers, and escape through the open win-

dow; or, if the window be closed, they swarm on the glass, and keep up a musical humming, closely resembling that of a swarm of bees at a distance.

A more elegant example of this kind of breathing apparatus is seen in the grub of the two-winged fly, *Stratiomys Chamæleon*. The funnel tail spreads into a beautiful star of thirty distinct rays, and with this structure the creature suspends itself to the surface of the water, as if it were a ceiling, and as it moves to and fro its changes of position may be noted by the shifting of the dimple on the surface.



LARVA OF STRATIOMYS.

In the little gnat, *Corethra plumicornis*, (Meigen) we have some further examples of the peculiar conformation of the larva, to enable it to respire in the water; but the larva is so transparent that it requires an expert microscopist, and an effective instrument, to work out the details as represented by Reaumur and Dr. Goring. The larva of this species is plentiful in our brooks, and worthy of close scrutiny by the aid of the microscope. Just now the gnats are abundant in meadows near streams, and to them we are indebted for that soft humming which has been appropriately termed the "music of the wild," and on which good old Gilbert White exhausted his ingenuity to find an explanation. The social communities of these ephemeral creatures are strictly music parties, and whenever we suffer them to assemble about our heads, when rambling in the hedge-rows, we are entertained by their fairy-like performances. *Expertum est.*

The Case Fly, *Phryganea grandis*.—There are several species in the family of *Phryganea*, which is the only tribe in the order *Trichoptera*, but such strong resemblances exist between the several members of the family that some entomological experience is necessary to enable the student to distinguish them. In an Aquarium, the caddis worms are very amusing, and since they thrive there, they are very suitable additions to the happy family. We see them busy at the bottom, adding fragments of weed, pebbles, minute shells, even if the snails within them are alive, and any small debris that their fingers can seize hold of. Last season I had amongst a large number of cads, one that had his case nearly destroyed by accidentally falling from the table. I removed from him what remained of his case, and threw him into a jar with a soldier plant and a few *Lymnea*. He set to work to repair his tabernacle, and the *Lymnea* helped him, for they nibbled a plant of *Stratiotes* into shreds. These shreds the cad gathered, and every day he added a fresh piece, so that, in about ten days, he appeared in a suit of green, his clothes bulged out to an enormous size, and everywhere studded with points and corners, the most comical sight that could be imagined. Since he could find nothing of a small neat pattern, he took what he could, and became a perfect Jack-in-the-green, nearly an inch and a half in length, and thicker than a carpenter's lead pencil.

The movements of these creatures are as comical as their specimens of tailoring. We see them mounting a stem or leaf with great gravity, when suddenly up goes the tail, the legs hold tight, and the case turns completely over, as if on the first of May, Jack-in-the-green were to dance on his head. When the creature is hidden, and the case sways to and fro like a buoy attached by too short a rope, the sight is very curious. This case-maker is the

larva from a fly which bears resemblances to the two families which stand on either side of it—the *Lepidoptera*, or true butterflies, and the *Neuroptera*, of which the dragon-flies and other membranaceous winged insects are members. As soon as he enters the world, he begins to shew his skill in tailoring, and by means of silken threads



LARVÆ AND IMAGO OF CASE FLY.

and gluten constructs his case of bits of sticks, straw, dead leaves, or shells, in fact, whatever he can get, and as long as he retains the worm-like form the case is his castle, and he can defy the world. The case outside is generally a rough affair, but if you draw out the cad you will see that inside it is perfectly cylindrical, smooth, and polished, and around the doorway, through which the larva makes acquaintance with the world, it is neatly

finished with a very circular rim. When you have removed a cad, if you throw him into a tank you will learn in an instant what is the use of his case, for his soft nakedness is no sooner exposed, than the minnows finish him, and find the flavour excellent. But to see a cad in his proper uniform molested is a very rare sight indeed. He passes his larva life innocently, and is an amusing fellow; when he feels the numbness of torpor creeping over him, the cad draws in his six legs, and sets to work inside to weave a winding-sheet and to shut the shutters, for he knows that his time is come, and there is no one to do such melancholy offices for him. All alone in his solitary cell, the hermit works day and night, and hourly his fingers grow more feeble. We look and find the shutters closed, and by this time the larva has changed into a pupa.

The mode in which the worm closes its cell is curious enough. Over its entrance it weaves a grating of silk, which hardens in water and remains insoluble. It may be seen very plainly by the naked eye, but under a good lens increases in interest. The grating is placed a little inside the margin of the opening, and fits exactly within it, and its object is to protect the pupa from invasion, and at the same time, to admit water for respiration. De Geer describes one of these gratings in which the pierced holes were disposed in concentric circles, as represented in the engraving. This, however, is not, as far as I am aware, the usual form of the grating, many that I have examined were formed in regular rays from a centre like the spokes of a wheel.



GRATING OF CASE-WORM, (MAGNIFIED.)

But the escape of the pupa, when about to undergo its last metamorphosis, is as interesting as the fact of its closing the shutters to announce its own death. It is provided with a pair of hooked mandibles, with which to gnaw through the grating, and no sooner have these accomplished their purpose than they fall off, and the pupa takes its last shape of a four-winged fly, as represented in the cut.

CHAPTER XII.

COLEOPTERA.

THE beetle tribe are distinguished from other insects by the possession of *elytra*, or wing-cases; which wing-cases are, with regard to the typical structure of an insect, to be regarded as really the first pair of wings hardened into a horn-like consistence to protect the others. The wing-cases are of little or no use in flight, this action being accomplished by means of the second pair, or the true wings, which are generally of large size, and when not in use are neatly folded up beneath the elytra. The division of the body into three parts—head, thorax, and abdomen—is very plain to the eye; but the segments, of which the several parts are composed, are frequently so consolidated that it is difficult to detect or count them. For instance, the thorax, theoretically, consists of three segments; but, practically, the first of these is usually so largely developed as to appear to constitute the thorax in itself. The (thoretical) nine segments of the abdomen are, in like manner, reduced to six or seven, in consequence of the last two or three being consolidated into one.

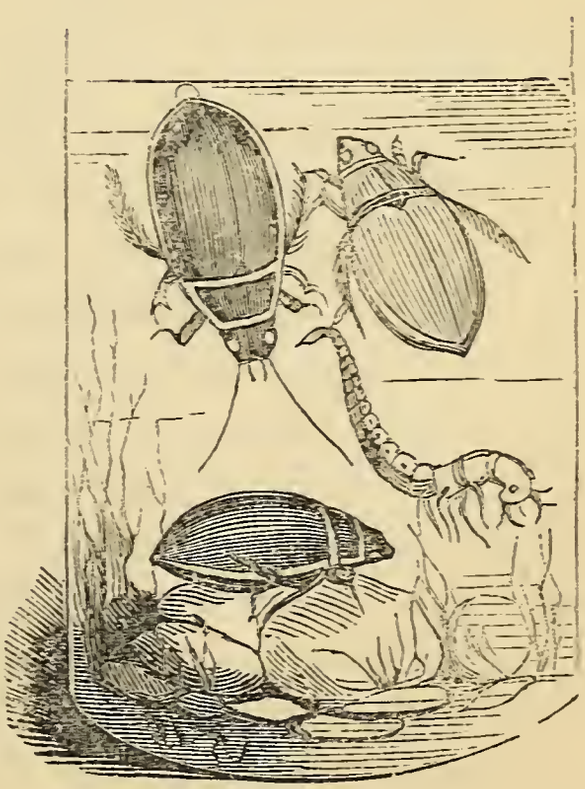
The order is an immense one, as to its range and variety, and hence there are in it many curious exceptions to the general conformation of a beetle. Some are utterly incapable of flight, owing to the non-possession

of elytra, or wings; some have elytra only; and in some the elytra meet and unite along the suture; so that, if the insects had wings underneath, it would be impossible for it to use them.

The specimens of coleoptera, kept in the water-cabinet, are among the most interesting of the whole collection, whether in the larva or imago form; and to this order we are indebted for a large number of aquatic species, that may be kept in jars, and some few that may be introduced without danger to the tank.

Dyticus Marginalis is one of the handsomest of water-beetles, and its habits are amusing and instructive. It possesses an insatiable appetite, and great muscular power, as we soon discover when removing it from one jar to another, for if it succeeds in planting its claws firmly on the edge of the vessel, it is difficult to move it. It belongs to the large tribe of *Aquatic carnivora*, ranged in the section *Pentamera*, in which the tarsi of all the feet are five-jointed, the fourth being of ordinary size.

The *Dyticus* is a true water-beetle, being aquatic in both its larva and perfect forms. The larva, known as the water-tiger, is found in plenty in the muddy ditches round London, and is a strong, stubborn, ugly, and ravenous worm, with a tail formed for respiration, and curved mandibles to tear its prey to pieces. It is very active, and may be kept without difficulty;



DYTICUS AND LARVA, (REDUCED.)

but nothing else should be placed in the same jar, unless intended as food for this savage. A small fish thrown in is eagerly clutched, and held firm by the claws; and the larva then plunges its mandibles into it, and is soon buried head-deep in the mangled body of its prey. I have generally fed them on beef, but they prefer small fish, or larva of the dragon-fly, and do not go through their metamorphosis well without such food.

The imago is a handsome creature, with strong hooked claws, furnished with amber hairs, which, under a lens, resemble very closely the claws of a crab. The elytra are beautifully tinted with rich green and bronze, and the divisions of the head and thorax separated from the abdomen by sharp, whitish lines. Small fishes make the best diet for this beetle; but as this food fouls the water, it is best to keep them in clear jars, with a few pebbles and weeds, and once a week remove them to another vessel to be fed. This plan preserves the brightness of the beetle-jar, and prevents the annoyance of effluvia.

Hydrous Piceus.—This is the largest of our native aquatic beetles, and, with the exception of the stag beetle, it exceeds in bulk any other species of indigenous Coleoptera. It is common in the brooks and ponds in southern counties, but becomes rare as we travel northwards. In the larva state this is a rapacious and blood-thirsty insect, and of so destructive a character as to deserve its French name of *ver-assassin*. In that early condition it resembles a large soft worm, of a somewhat conical form, provided with six feet, and having its large scaly head armed with two formidable jaws. The head moves with such freedom in all directions, that it can readily seize small shell-fish and other mollusca floating on the surface, without altering the horizontal position of the body maintained in swimming; and it is even bent backwards, and devours its prey more conveniently by using the

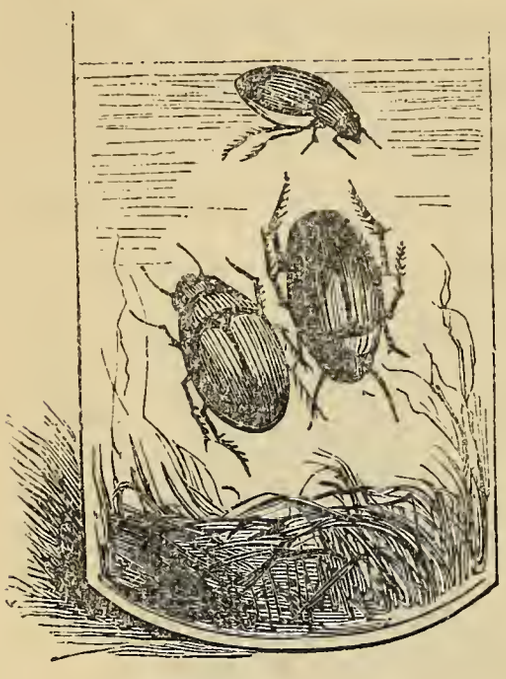
back as a kind of support. These larvæ swim with facility, and have two fleshy appendages at the tail, by means of which they suspend themselves at the surface with their heads downwards, when they have occasion to respire, *(Cuvier.)* The beetle differs greatly in habit from the grub; it is by no means carnivorous, but quite harmless, docile, playful, and tameable. It is a noble creature for the cabinet, and may even be kept in the Aquarium safely. In its complete form it is as interesting for its gentleness as it is in the larva state for its rapacity and destructiveness. The female spins an elegant and waterproof cocoon for the reception of its eggs, and when they are deposited she will watch them with a maternal solicitude not frequently exhibited by creatures of this family.



The *Hydrous piceus* is here represented of the natural size; the ground colour is black, with a shade of bronze, and the margins of the elytra are tinged with green and purple. Each wing case is marked with dotted lines, the breast is dingy yellow, and the antennæ and organs of the mouth dull red. The legs are black, and the hairs which fringe the tarsi reddish brown.

Colymbetes, of several species, may be obtained in plenty from clear brooks in every part of the country. These are elegantly-formed and lively beetles; their elytra,

legs, thorax, head, and breast of the same jet-black hue, and highly burnished, though, when immersed, the breast and abdomen glisten with an intensely metallic silvery lustre, owing to the film of atmospheric air which the beetle obtains from the surface, and which adheres to the hairy covering of the abdomen. This silvery species is here represented in its natural size. They are comparatively harmless, though I have just witnessed the demise of one that was attacked and eaten by his pretty kindred, the wing-cases and head only remaining to testify of his former individuality. This is a delicate beetle, that requires very pure water and a neat arrangement of aquatic plants, to give full effect to its beauty as a cabinet specimen, and, when carefully preserved, a jar of them forms a conspicuous and attractive object.

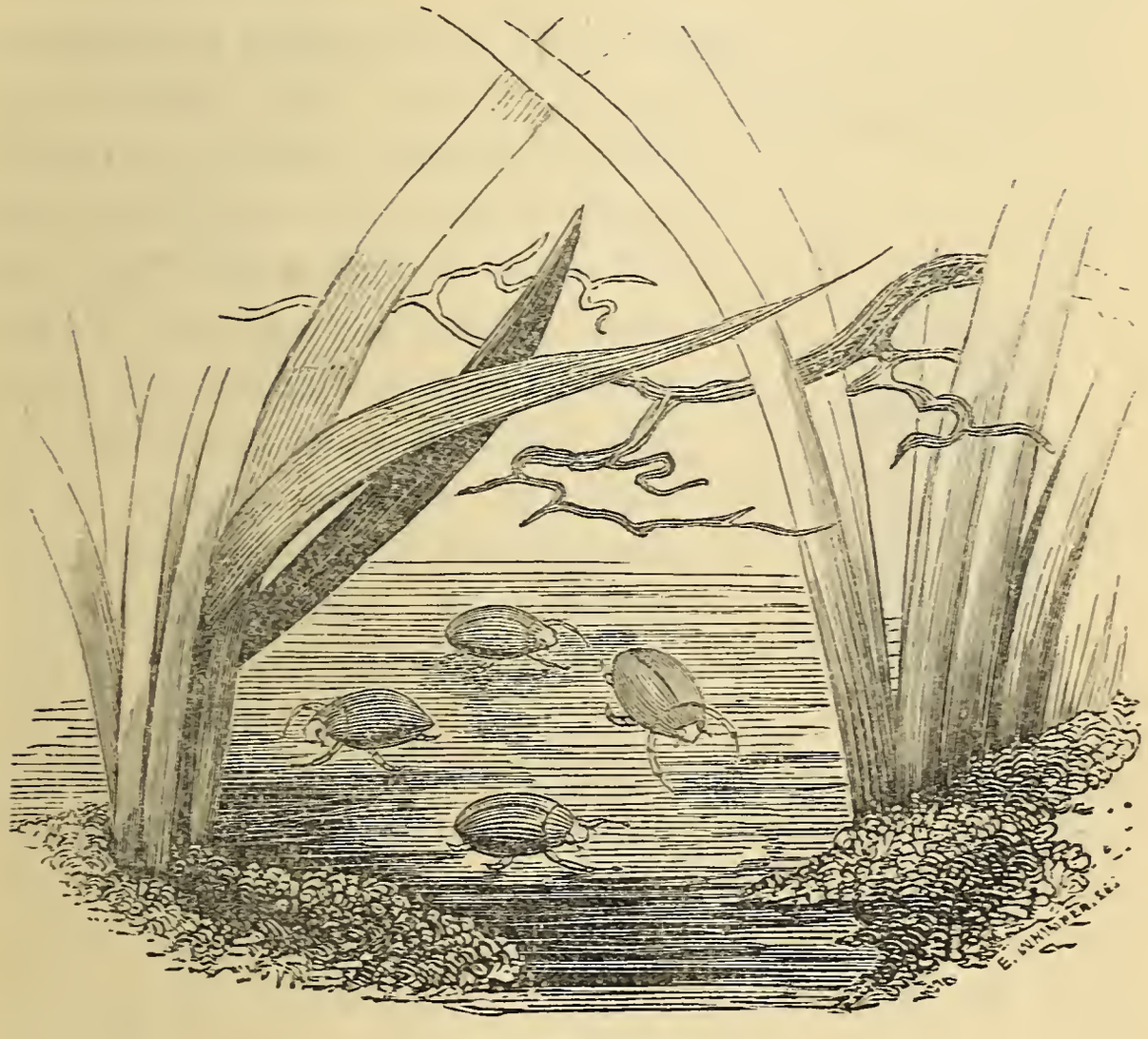


COLYMBETES.

GYRINUS NATATOR.—This is a member of an interesting and pretty family. *Gyrinus* takes its name from the tendency most of the beetles of the tribe have to *move in circles*, and this particular species exemplifies the habit of the tribe in a very striking manner. It is a very sociable beetle, always found in company with others of its kindred, forming little communities, which pass their time in whirling and spinning upon the surface of still pools, like congregations of dancing dervishes. They are as shy as they are nimble, and it requires some dexterity to net them, for they dive and scatter on the approach of a footstep; but if the observer remains quiet a few minutes by the water's edge, or on a plank or bridge above the pool, they soon resume their gambols under his eye, and

in the sunshine appear like minute buttons of burnished metal rapidly revolving or darting to and fro upon the surface, and for a length of time that proves them to be by no means subject to giddiness.

The species of *Gyrinus* are not numerous in Britain, not more than eight being known to naturalists; but the

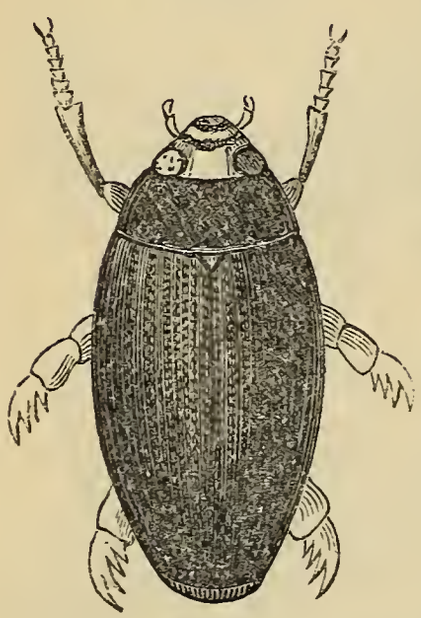


GYRINUS NATATOR.

paucity of species is compensated by the profuseness of the individuals, and of these *natator* is the most abundant. When placed under a lens, this beetle bears the form represented in the next page. The colour is blue black, with a resplendent metallic lustre, in which shades of copper, silver, and bronze occur, as we view it at various

angles to the rays of light. The thorax is marked with three transverse lines on each side, of which the anterior one is punctured, and runs parallel with the margin. The elytra are turned in at the sides, and the surface of each is marked with eleven striæ or longitudinal lines, composed of minute punctures. The terminal segment of the abdomen, together with the legs, are of a rust-red.

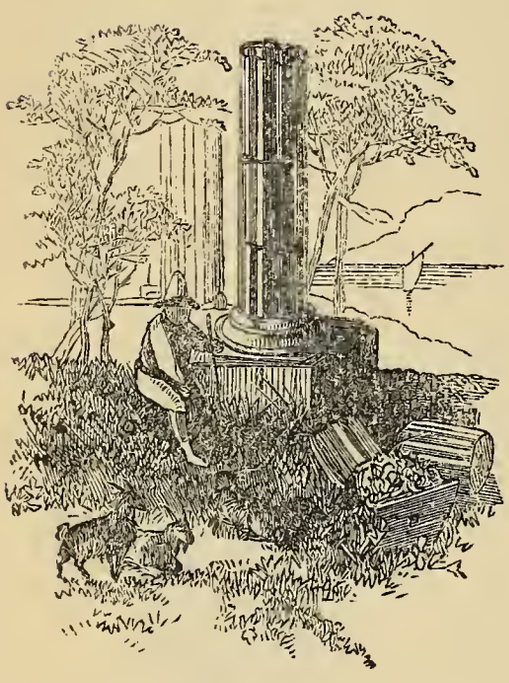
If we inquire by what means it is enabled to perform its elegant gyrations on the water, and which very closely resemble those of a skilful skater on the ice, we find that its structure is eminently fitted for such peculiar movements. In the first place, the antennæ are short and thick; if they protruded forward to a great length, as in *Longicornes*, they would seriously impede the freedom of action, which is the life and joy of this nimble fellow. They are clavate, and consist of seven closely-jointed rings, each antennæ being attached by a slender peduncle to the upper and internal edge of a large radical joint furnished with an auricle at its outer side, which, like the lid of a box, shuts in the antennæ when unemployed, and protects them from the water, *(Kirby.)* The anterior legs are long, and formed for walking or to act as instruments of prehension; the four hinder ones are very short, and ciliated externally, bearing a strong resemblance to the paddle of an oar. "The head is sunk in the thorax as far as the eyes, and the latter are divided by a process from the anterior part of the head, in such a manner that there appear to be two eyes above and two below —a mode of structure admirably adapted to the wants



of the insect, which requires at the same time to observe objects both in the air and water." The hinder legs are capable of a free oar-like action, which render this *gyrinus* the most expert of swimmers, and the circular movements are accomplished by the more rapid action of the oars on one side than the other. So equipped, the whirlwig leads a merry life; he skates away from morning to night, never in fear of being drowned, and seemingly never tired.

CHAPTER XIII.

HETEROPTERA.



IN the Cuvierian arrangement the land and water bugs stand between the true beetles and butterflies, and in those members of the order which possess wings, the chief characteristic is, that the anterior pair fold nearly horizontally, partly lapping over each other, and are of a leathery texture at the base. The majority of the members of the order are inhabitants of tropical climates, and some of them display colours equal to those of the true beetles. Not a few have the power of emitting powerful odours, in some cases of an agreeable nature, and in others—as the common bed bug—of a most disgusting nature. The order readily separates itself into two great divisions—namely, the *Geocorisa*, or Land Bugs, and the *Hydrocorisa*, or Water Bugs. Both divisions supply a few specimens for the Water Cabinet, but the most important are those belonging to the second class.

Among the first class in this order the most interesting is *Hydrometra stagnorum*, or the Water-measurer, which may be seen treading the surface of still brooks and rank pools in summer-time, in company with swarms of tipulidan gnats, *(Chironomi)* whirlwigs, and two other

aquatic bugs, the *Gerris locustris* and the *Velia currens* of Latrielle. The *Hydrometra* is a lively creature, a body so slender as to be little more than a black line half an inch in length, from which the long and angularly-jointed legs proceed in regular pairs. Under the microscope the divisions of the body are very plainly and prettily marked, and the terminal processes of the legs are made after the model of those water-shoes with which a certain clever Norwegian lately undertook to walk on water with nearly as much ease as on land. Whether the mechanician ever succeeded in the enterprise is not on record, but it is on record in the Book of Nature that this, and many other similarly-formed creatures, have found on the aqueous element a safe flooring for their feet ever since the first hour of creation, ere He who equipped them, had sent his Son to walk upon the waves.

Notonecta and *Nepa* are of the same order, but are true water-bugs, formed for diving and sub-aqueous life. The *Notonecta*, or Boat-fly, is a rapacious creature, that spends much of its time lying in wait for prey, but which exhibits immense activity when it captures its booty, darting down with it, and holding it firmly by the fore-legs, which are formed as claws. It is ingeniously adapted for the predaceous aquatic life it leads: the general form is well adapted for propulsion through water, and the hinder legs have an oar-like form, and are fringed with bristles along the edge, by which their striking surface is much increased. The boat-fly is an artistic swimmer; it varies its motions considerably, and delights in swimming on its back, a feat in which it is aided by its eyes being so placed as to enable it to see both above and below, and thus gain early intelligence of danger, or of the approach of its prey. Owing to their liveliness and voracity, they afford much interest when domesticated, and should be treated as directed for *Dyticus*.

The Water Scorpion is a good representative of the

Nepidæ, and has the distinguishing features of its tribe very strongly marked. The Water Scorpion is a very common inhabitant of our brooks, and its singular form quickly arrests the eye of the sportsman when turning over the contents of the drag-net. *N. neptunia* and *N. cinerea* are, perhaps, the most common; and either of these is an admirable object for the microscope. The water-scorpion is the victim of the parasitic water-mite, *(Hydrachna abstergens,)* which inserts its egg in the body of the Nepa, and thus compels it to support the young of its worst enemy, a task which it performs at the cost of its life. I have several times introduced the *Hydrachna* into my jars of Nepa, but have never yet witnessed the parasitic deposit of the eggs. In confinement, the Nepa is the least hardy of any creature in the collection, if the sun strikes the jar it perishes, and it will not live long unless it has means of occasionally leaving the water—hence a broad jar should be used for it, and a small piece of pumice stone should be floated in it, to form an island to which the insects may resort.



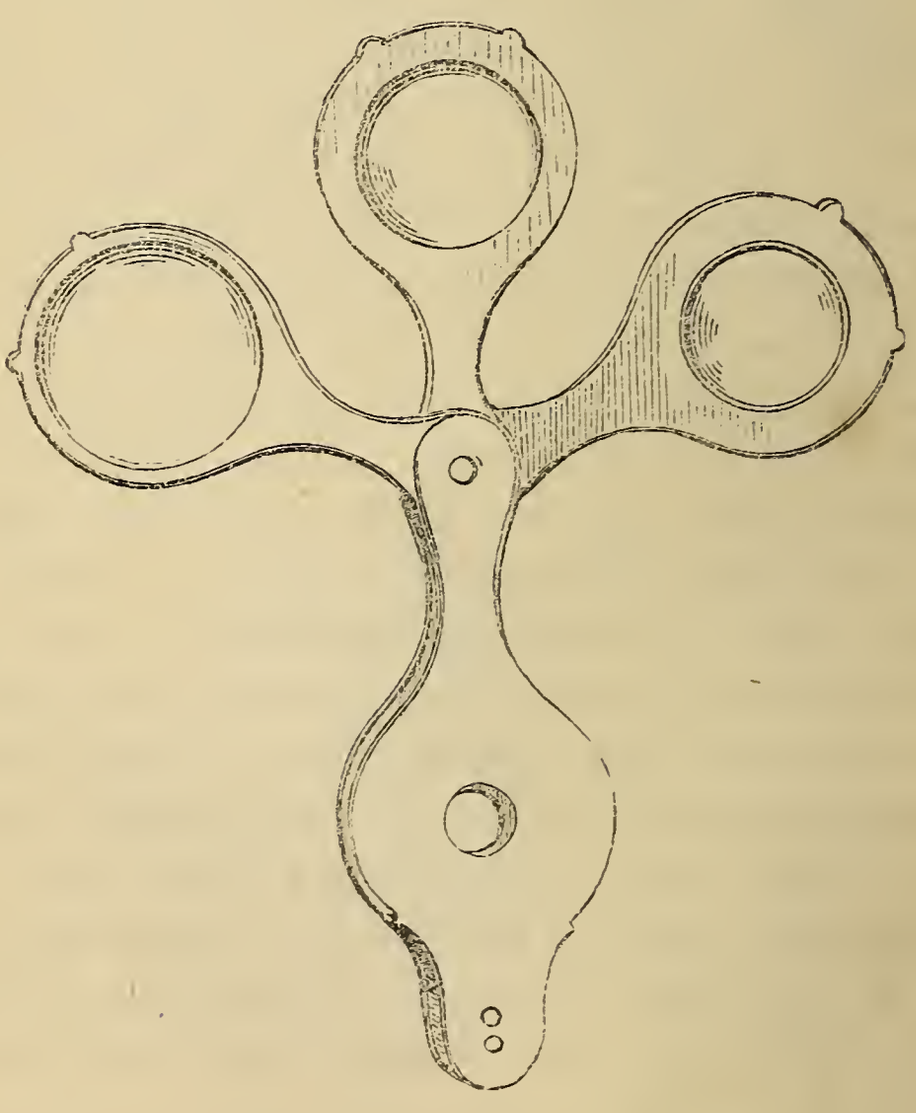
CHAPTER XIV.

THE MANAGEMENT OF THE CABINET.

THE instructions already given for the management of aquaria will be found to embrace most of the points involved in the management of beetle and larva jars, for these are but aquaria on a smaller scale. The chief matter is to separate the species as much as possible, so that the carnivorous kinds shall not destroy the harmless ones; and on this plan the study of each kind is greatly facilitated. Since the jars afford the best means for the culture of choice aquatic specimens of the various kinds of *Riccia*, *Conferva*, *Nitella*, and *Lemna*, such minute water-weeds should be used for maintaining the necessary balance in each, and if some of the vessels are filled with brook-water only, the student will come into possession of many valuable examples of animal and vegetable life. Feeding is necessary in the case of carnivorous larva, or they will devour each other until there is but one left; small pieces of beef, or small red earthworms are the most conveniently obtainable kinds of food, but any soft-bodied insects will suffice. Of course, the water in the vessel is not to be changed unless by the death of any of the creatures it becomes foul, in which case set matters right as quickly as possible.

The possession of a first-class compound microscope

is essential to a pleasurable and profitable study of the lower forms of aquatic life, and indeed without a microscope one might as well in these days confine one's scientific studies to Joyce's Dialogues and the old cylinder electrifying machine. For ordinary observation and determination of species, a common hand lens will suffice. For a careful examination of minute objects not requiring the powers of a compound, there is nothing better than a Coddington lens; and as a good accompaniment to the Coddington for the pocket, and to take into the fields when collecting, the three-power lens, which may be obtained of any optician for seven shillings, is most valuable.



CHAPTER XV.

THE ripples seem right glad to reach those cresses,
And cool themselves among the emerald tresses;
The while they cool themselves, they freshness give,
And moisture, that the bowery green may live;
So keeping up an interchange of favours,
Like good men in the truth of their behaviours.

KEATS.

AQUARIA FERN-CASES.



HITHERTO the Aquarium has been considered in its simplest forms, and fountains, ferns, and other of the high departments of Aquarium culture have been alluded to but incidentally. At this stage I may enter upon certain extensions of the original idea, and devote at least one short chapter to a few suggestions which arise out of the experience I have acquired since last addressing the public through these pages.

In the first edition of this work, I suggested that the fresh-water tank afforded a good opportunity for the lover of ferns to attempt the cultivation of many choice kinds in connection with it, and that suggestion has been pretty extensively carried out, with more or less success, by many ardent cultivators.

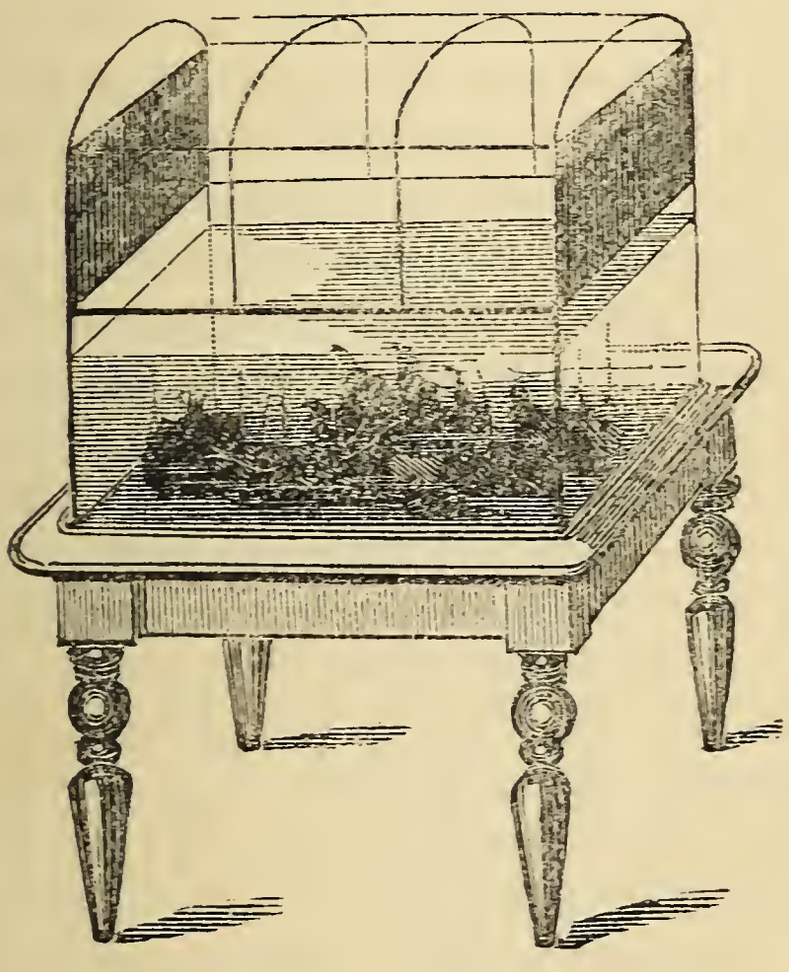
There are several modes of combining the Wardian Case and the tank together. A moderate-sized tank may be very readily adapted for the growth of ferns, by having the inner sides lined with a narrow border of zinc, and the centre left open. This border would comprise first a narrow shelf, running round about four inches below the top of the vessel, and at the edge of this shelf next the centre of the tank, a perpendicular edging of four inches, so that the zinc-work forms a trough or border. This trough is to be filled with peat, the ferns planted in it at proper distances from each other, and a glass dome or frame fitted over the whole. The upper frame should be fitted with a door, and the simplest way to accomplish this is to have one of the glass squares attached to hinges, so that it may be let down whenever the live stock or ferns require attention, or a breath of fresh air seems desirable. The ferns grow rapidly in the moist air by which they are surrounded, and soon fill the upper frame with their feathery verdure, so that, though there is but a border of them, the whole of the upper case appears filled.

A still more elegant way is to pile up rock-work in the centre of the tank, and bring its summit three or four inches above the water. This central pile will serve to hide the supply-pipe of a fountain, and the ferns need not therefore be inclosed with glass. The ferns are then planted in the hollows left for them among the stones, and guarded against excess of moisture by means of a layer of potsherds and broken limestone

under each, or pockets are made round the jet to receive plants in pots, which is better than planting in *situ*. The fountain plays above and over them, and while its

"Crystal bubbles
Charm us at once away from all our troubles,"

it adds to the sparkling freshness of the graceful foliage, and, by keeping up *a run* in the tank, enables us to



FERN-CASE AQUARIUM.

double the number of gold and silver fishes that could be safely preserved without it. In selecting ferns for this purpose, those only should be used which naturally delight in an abundance of moisture, and which are usually met with in dripping caves and under waterfalls.

The same mode of growth may be adopted without a fountain, by placing over the tank a close frame, with

a door, as in the former case; or the masses of rock may be built up on each side, and an architectural fountain fitted in the centre. The manufacturers produce tanks with cases fitted expressly for this mode of culture; one of these is here represented.

If ferns of large growth are to be grouped under a fountain, the rock-work must be built up above the surface some four or six inches; a compost of sharp sand, turfy peat, and small charcoal must be prepared, to fill the pockets for the ferns to root in. Care should be taken that the root-stocks are prevented reaching the water, either by the upper surfaces of the stones themselves on which the compost is placed, or by some pieces of broken flower-pots laid horizontally, with the compost on them and concealed by the superstructure, but sloping from the centre, so that the water of the fountain will readily run off into the tank; should it form pools about the roots, it may sodden and destroy the plants; small clefts are sufficient for the escape of young fronds.

The root-stocks must be planted in the compost, and should, if possible, be chosen when they are just putting out new fronds. The old fronds had better be cut off, and the rhizoma trimmed down so as to leave but a small portion attached to the crown, and the stones built round the shooting stems so as to afford them no more room than they will require, and so that most of the falling water will run off direct to the tank over the rock-work, without penetrating to the root-stocks below. The latter will get as much as the most water-loving ferns require, in spite of all precautions to prevent the water flowing freely to their roots.

When the root-stocks are planted, it will be well to stuff the crevices with moss, through which the fronds will easily protrude. The moss will prevent any undue exhaustion should the sun shine powerfully upon the

tank, or should the fountain only play occasionally.

Another plan of fitting a rectangular tank with ferns is to have the lower portion formed in the ordinary way, but of less depth than usual, and then in this to build up a large mass of rock-work so as to form an arch *above and apart* from the water. This rock-work may either be wholly composed of cement, with suitable hollows for the insertion of the plants and the compost, or a number of blocks of granite or any other rough and picturesque stone, may be cemented together firmly and tastefully. Over the whole of the arch, ferns, lichens, lycopodiums, choice bog plants, epiphetes, and moisture-loving creepers may be grown, and a magnificent scene produced of fishes gamboling in the open water, and under the dark shadow of the arch which spans the centre, while above creep, and twine, and wave the chastest and brightest of vegetable creations, revelling in the moisture, and rejoicing in the partial shade that the glass enclosure secures for them. A construction of this kind, designed by Mr. George Voyez, is represented in the frontispiece.

There is yet another mode of combining the two elegances, and that is by means of a common fern-shade, the dish of which forms the Aquarium, and the shade above a cover for the ferns. My first attempt at this combination was made by means of a sixteen-inch fern-shade. I explored almost every glass warehouse in London, as well as the several bazaars, to find a fluted pillar with a spreading summit to fit in the centre for the reception of the ferns, and failing to find anything to my taste, I stole a green glass flower-vase of my wife's, and proceeded as follows:—I placed the vase in the centre, and piled pebbles round it to keep it steady, and spread a continuous bed of similar pebbles over the bottom of the Aquarium dish. The vase stood

fifteen inches high, had a firm spreading base and a fluted-lipped summit that spread over to a breadth of six inches. Into the vase I then dropped a handful of broken flower-pots, then a little old mortar, and then filled it up with a compost of peat, silver-sand, and pounded charcoal. I then planted in it the brittle bladder fern, (*Cystopteris fragilis*,) the pretty *Trichomanes Tunbridgense*, and the adder's tongue, (*Ophioglossum vulgatum*.) Around the roots I placed two pretty *Lycopods*, namely, *Lepidopterum* and *Willdenowii*. The dish was stocked with *Hydrocaris morsus ranæ*, small tufts of *Myriophyllum spicatum*, *Stratiotes*, *Chara*, and the only fishes were six small picked specimens of *Cyprinus auratus*—the prettiest gold-fish I had ever seen.

This did well, but there was one objection to the whole affair, and that objection I had seen repeated in every fern-shade Aquarium I have hitherto inspected, whether on the smallest or largest scale. The evaporation is of course immense at all times, and it is confined; when the sun shines on the vessel, the evaporation is increased, and such a condensation takes place on the upper shade as for a time prohibits a view of the lovely scene within. Since we do not light a candle to put it under a bushel, this objection is almost fatal. In a case made with a door a temporary remedy is to be found in occasionally syringing the inner sides of the glass so as to carry down the moisture in a stream. Another partial remedy is to open the door during the warmest period of the day, and allow the vapour to escape: but these are only partial remedies.

Still, in fairness, it must be stated that the opaque condition of the glass is not permanent. If the tank can be kept at nearly the same temperature as the air that surrounds it, the condensation is very trifling;

hence in the morning and evening the glass is generally pretty bright, and the scene may be contemplated with pleasure; it is the *difference* in temperature between the water within and the glass surrounding it, and the air without that causes the evil, and to prevent it, sunshine must be as much as possible excluded. A sheet of perforated glass of the kind now used for ventilating purposes might usefully be inserted in the top of a rectangular frame, to facilitate the escape of moisture; but in an ordinary fern-shade such a remedy is not available. A double case, with a space of an inch or more between them, would very much obviate the inconvenience, by surrounding the inner glass with a stratum of air of the same or nearly the same temperature as that prevailing within.

But the fountain carries the day in the combination of the fernery and the Aquarium, though in spite of the evil I have so lengthily dwelt upon, the combination is worth effecting, and the view will be open and undimmed sufficiently often to remunerate whoever has the patience or the means to carry out the scheme in its full integrity.

Mr. H. Baines, of the Yorkshire Philosophical Society, some time since published an account of a fern-shade Aquarium which proved eminently successful. It consists of the ordinary glass vase and dish, the latter made slightly tinged with blue; in the centre of the Aquarium dish is inserted a pedestal of glass, and on this is placed a blue glass dish or tazza, made to fit on the top of the pedestal, as in the engraving at the head of Chapter I. The bottom dish is covered with a layer of soil, (in my opinion unnecessary,) and this is covered with pebbles. The dish on the pedestal is also filled with soil, (peaty of course,) and planted with plants suitable to a Ward's case. The Aquarium is then

stocked and filled, and the bell-glass fitted into the rim of the Aquarium.

The following selection is adopted by Mr. Baines:—

Fishes—Small Gold Fish, Minnows, and Sticklebacks.

Mollusks—Succinia putris, Planorbis corneus, carinatus, and marginatus, Cyclas rürcola and cornea.

Water plants—Vallisneria spiralis, Aponogeton distachyon, Nymphæa odorata minor, and Nymphæa macrantha.

For the Wardian Case—Adiantum capillus-veneris, Lastræa dilatata Schofieldi, a beautiful small Yorkshire variety, Asplenium viride and trichomanes, Asplenium fontanum, etc.

Lycopods—Willdenowii, umbrosum, stoloniferum, mutabile, densum, and lepidopterum.



Sagartia dianthus, Delesseria sanguinea, Callithamnium roseum, Griffithsia setacea.

THE BOOK

OF

THE MARINE AQUARIUM;

OR

PRACTICAL INSTRUCTIONS

ON THE FORMATION, STOCKING, AND MANAGEMENT IN ALL SEASONS, OF COLLECTIONS OF MARINE ANIMALS AND PLANTS.

BY SHIRLEY HIBBERD,

AUTHOR OF "RUSTIC ADORNMENTS FOR HOMES OF TASTE," ETC., ETC.

A NEW EDITION, REVISED AND ENLARGED.

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PREFACE.

I HAVE followed in the preparation of this work the plan adopted in the companion volume on the "Fresh-water Aquarium,"—that of indicating, rather than describing the several subjects that present themselves for investigation, and treating more at length than other authors have done, the rationale of management. To set up a tank and manage it in accordance with sound principles, is not such an easy matter as some writers have represented it. Those only know the difficulties which beset beginners, who have again and again made the subject one of experiment; and hence some writers, otherwise estimable and able men, have laboured assiduously to describe the various forms of life to which the Aquarium introduces us, and have said little or nothing on the system to be pursued to render those forms of life amenable to the conditions under which the aquarian desires to observe them. I shall absolve myself at once from any possible charge of instituting comparisons, by acknowledging that there are many more scientific, perhaps more interesting, and certainly more copiously descriptive works on the subject than this, but there is none in which the practical aquarian has pointed out to

him more definitely the sources of danger and the method of accomplishing success. My books sell largely because I teach people how to do that which I have done myself; these practical arts are not to be guessed at, and generalities are apt to lead people astray in all pursuits where actual manipulation forms the basis of the result desired. I take credit to myself for having cleared away many of the errors that have prevailed in the management of aquaria, and for having set forth pretty definitely the principles on which the student should proceed from the very first. That is *all* that I have attempted in this new edition of the "Book of the Aquarium," with which a few botanical and zoological notes are incorporated merely as introductory lessons, which may be followed out to any extent commensurate with the present state of science, with the help of more technical and more elaborate works. As the instructions here given are the result of personal observation and experiment, including no small expenditure of time and money, I here put up the notice which appears in the preface to the other portion of the work—*Pirates Beware.*

S. H.

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"A sounding grotto, vaulted, vast,
O'erstudded with a thousand, thousand pearls,
And crimson-mouthed shells with stubborn curls
Of every shape and size, even to the bulk
In which whales harbour close, to brood and sulk
Against an endless storm. Moreover, too,
Fish—semblances of green and hazure hue,
Ready to snort their streams." KEATS.

CHAPTER I.

THE INVITATION OF THE SEA.

HERE needs no voice of poet to give new zest to the old thirst for a knowledge of the wonders that are hid beneath the waves. How in the season when the deep green of summer begins to wane, and the faintest tinge of autumnal orange appears like a blotch of lost sunshine on the landscape, do our thoughts revert to the vast, and unchangeable, and mysterious sea—

"The glorious mirror, where the Almighty's form
Glasses itself in tempests."

Unchangeable it is, though relatively ever changing; unchanging in its character, its office, and its plenitude of life, yet changing to us in its many modes of storm and calm, the glittering of its white foam in the sunshine, and the roar of its stormy waters in the awful darkness. We have never seen enough of the sea, for it never tires, though we visit the same bay, or the same creek, or the same breadth of snow-white beach, day after day; for the water has a life of its own, and its successive phases of playfulness, rolling grandeur, gentleness, and power chain the mind to it, and while intellect strives to master some of the problems its phenomena suggest, the imagination and the fancy find therein inexhaustible poetry, indescribable beauty, and all the elements of fear, and joy, and wonder, and repose. Besides its own individual life, which compels us to invest it with some of the attributes of a creature gifted with purpose and volition, and capable of both love and hate to man, it holds another life within it, which the mind reaches after, which the hand reaches after, and, like another and a new creation, demands that man should stand in the midst and name the creatures. The fresh sea breeze,—the calm expanse of blue, shading into mists flaked with distant sails on the horizon,—the towering moorland and the grandeur of the cliffs, that shew the scars of centuries of storm and battle,—the music of the breakers, following in quick succession along the yellow strand, maintaining there a constant line of whitening foam,—the vastness of the expanse, and the nothingness of man in the presence of it,—these do not suffice us as we stand upon the shore yearning for knowledge after the creation that is hidden in the depths. There is one comfort—the conquest of

the earth, given to man as a high and blessed privilege, extends to the sea also; it is to him a storehouse of wealth, to be sought in danger, and a storehouse of wisdom, to be explored in reverence; every one of its strange people offering a fresh lesson of the infinite goodness and infinite power of the Source of all things.

It is in this search that we betake ourselves to the Aquarium, and find it of priceless value, because it places before us for daily observation in the quiet retirement of our homes, things born and nurtured in the depth of great waters, and enables us, in places far away, still to believe that the sea is near us in the tiny imitation of it we have set up for our amusement. The Marine Aquarium ranks as much higher than the river aquarium as the sea itself transcends in glory the smallest of the hill-side rivulets, that hurries towards it as its final home. The range of subjects it embraces is a hundred-fold more extensive and wonderful than the river tank can ever be, and it provides occasion for the study of creatures that lie out of our ordinary path of observation, and which charm us by their novelty and beauty no less than by their structure and habits, and several phases in the order of created life. Therefore the setting up and managing of a Marine Tank is a higher task than that of furnishing one with fluviatile subjects, and, like all other such enterprises, it is less easily accomplished, and calls for a larger exercise of judgment, and a more complete knowledge of first principles.

Happily for science, as well as for recreation, which of necessity is its proper attendant, the Aquarium has come to have a definite meaning, and such a degree of certainty has been attained in its construction and management, that we need no longer speak of it as one of the hazardous enterprises of the enthusiastic

student. Observation and experiment have in a few years settled most of those points about which there was at first so frequent a controversy, and the conditions of success may be stated in such a way as to ensure to every beginner a safe and certain progress from the first. It has been my privilege to do something towards making the Aquarium known as an embellishment of the Home of Taste, and also to lend a helping hand to thousands of students in this and other countries, by pointing out the sources of danger, and the methods of procedure on which success must be based; and now that experience, acquired by patient experiment, has changed the whole aspect of Aquarian science for the better, I hope to aid the cause still further by a new and more complete code, of imitating in tanks the actual processes of nature.

An Aquarium must be constructed in accordance with the use to which it is to be put, and therein are more matters for minute consideration than have been hitherto imagined. We now know with a considerable degree of certainty how the several tribes of animals and plants, that come before us for consideration, comport themselves in the confined space we would have them thrive in; and we know also, as the result of many sacrifices and disappointments, what degrees of light and heat affect the collection for better or worse, and, in fact, the risks attending the management of tanks has been reduced until we scarcely recognise their existence, but proceed in strict accordance with first principles, and accomplish the wished-for result, without feeling that any, even the least accident, is a necessity of the undertaking. Let us now consider a few preliminary matters, and then proceed seriatim to the practical work of collecting and keeping living examples of the inhabitants of the deep.

CHAPTER II.

TANKS FOR MARINE AQUARIA.



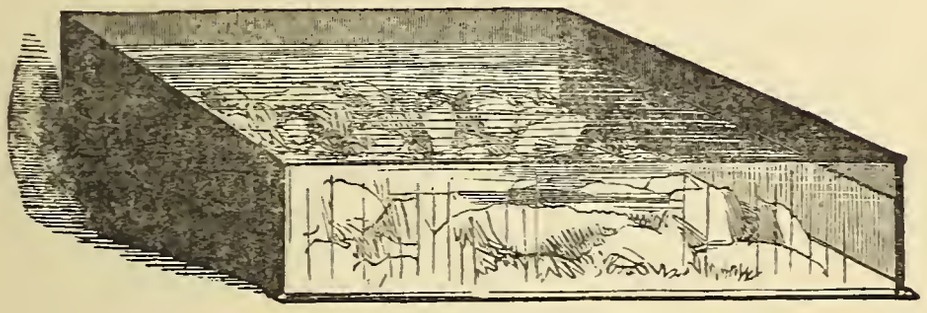
N the "Fresh-water Aquarium" I have stated in brief the conditions to be sought in the construction of tanks, but marine creatures are not so easily kept as river fishes, and the dimensions and forms of tanks are matters of the very first importance. For instance, we may have river tanks of any depth without fear of losses, because the supply of oxygen can be obtained more readily and more abundantly; and the tanks will bear more light than would be safe for marine vessels. Besides this, the inhabitants of river tanks are possessed of higher powers of locomotion, and can travel where they please within the limits of the vessel; but an *Actinia*, or star-fish, will be likely to travel to the bottom, and die there for want of the life-sustaining element. Therefore it is important, that whatever are the dimensions or forms of Marine Tanks, they must be shallow, and the object sought in determining their forms and sizes should be to expose as large a surface as possible to the atmosphere, consistent of course with the cubical contents of the tank. If they were made so shallow as to afford only just sufficient depth for the creatures to be quite immersed, it would be far safer than to proceed in the other direction, of giving more depth than needful. Take account of whatever Aquarium failures you can remember amongst your

friends, and you will invariably find that the vessels which gave the most trouble and the largest percentage of losses, were over a foot deep, and if we adopt for marine stock the rectangular vessels that were made in plenty when the Aquarium first became popular—vessels that were generally constructed with four sides of glass, and a depth equal to half or more of their length—we shall consign to a tomb every item of marine stock committed to it. Instead of preservatories such tanks are sepulchres; river fishes may need no better, but marine zoophytes soon perish in them.

On this subject of the form of vessels every aquarian must take a lesson from what has been accomplished by Mr. W. A. Lloyd, of Portland Road, Regent's Park. To him we are indebted for the invention of proper tanks, and the mode of successive improvements in the method of management, which have given so great a degree of certainty to the practice. The thousands of animals kept by Mr. Lloyd in a perfect state of health and vigour for sale, are in a series of shallow vessels of slate, through which there is a constant flow of water, the proportion of surface exposed is perhaps not less than one-sixteenth of the whole bulk of water in them, and thus there is a constant absorption of atmospheric air, and vegetation is not required at all. In the drawing-room aquaria fitted up by the same persevering naturalist, the exposure of a large surface to the atmosphere is always aimed at as a first necessity, other aids coming in to still farther ensure a due aeration of the water. There is no occasion for a run through the tank, because the most complete aeration can be accomplished without it; but the imitation of a tidal flow is not only possible, but easy, and where it is adopted the number of specimens may be largely increased.

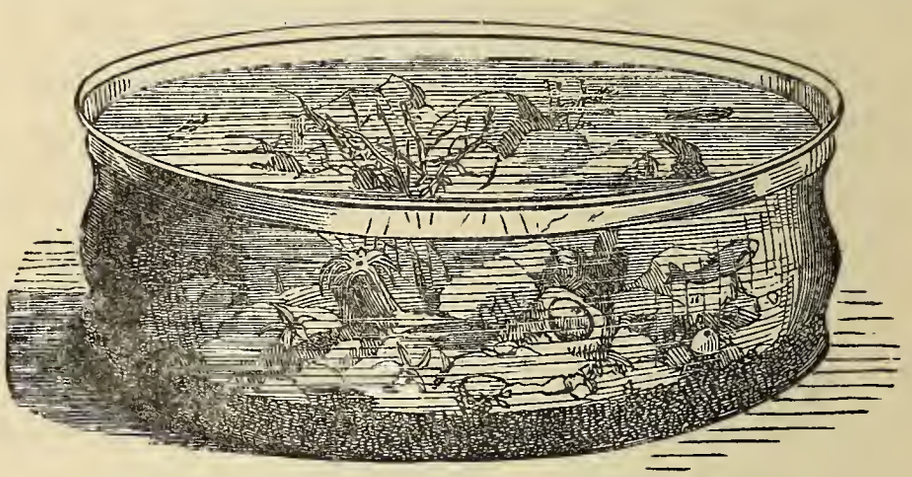
ROCK-POOL TANKS.

To smooth the way for beginners Mr. Lloyd has adopted a cheap form of shallow tank, which is here



figured. These are sold at thirty-five shillings each. They are made with bottom and three sides of slate, and the front of glass. Though they vary in proportions, they may be generally described as eighteen inches square and four inches deep. Now you must have observed, if at all conversant with these pursuits, that *Actiniæ* that have been consigned to a glass or earthenware dish while the tank was being prepared for them, exhibited every sign of vigorous health. When transferred to the tank the trouble and vexation began ; yet perhaps you never reflected that the dish was the best place for them, and the tank the worst. What is the lesson taught thereby ? Plainly that your tank was too deep ; they prospered in the vessel which held barely sufficient water to cover them, but began to decline, and ultimately perished in that which by its very depth, appeared more like their proper home. True, the sea is deep, and true also that most of the creatures kept in tanks are from its shores, where they are often laid bare by the receding tide, or with the merest film of water over them, to preserve them cool and moist in the sunshine. But there is another reason why we must not be led astray in supposing that deep vessels offer

the best conditions for our purpose. The sea is too vast a mass in itself to bear comparison as to its internal economy with a tank containing but a few dozen, or even a few hundred gallons of water. Its constant motion suffices to entangle and carry far down below the surface immense supplies of atmospheric air, and its abundant vegetation and profusion of infusoria also contribute to the most complete aeration of its waters. Therefore for the pelagic or deep-sea life shallow tanks are still the best, and if you are at this moment puzzled how to make a deep vessel answer for marine stock, give it up, and provide yourself with one of proper make and character. These shallow vessels made



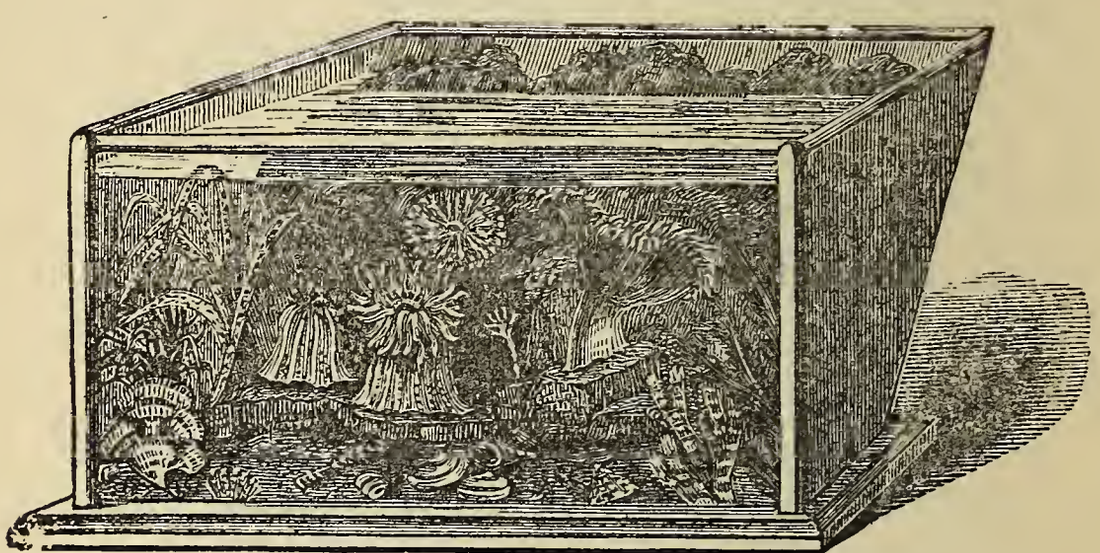
expressly for beginners, may be imitated in an inexpensive way, by means of a glass dish, an earthenware foot-bath, or any other vessel not metallic, of similar form and dimensions. As the appearance of the thing is, in many cases, all-important, it is with no small pleasure that I can bear testimony to the beautiful appearance of these shallow tanks when stocked with a suitable variety of zoophytes. The view from above is the best, for then we see the expanded rays directly, whereas from the front we generally have an oblique view, unless some considerate anguicoma or dianthus turns his face full upon us, away from the glare of light which the window admits upon him.

From this simplest of all forms of vessels let us proceed another step. The vessels with four sides of glass admit a vast deal too much light; the consequence is, that some of the inhabitants commit suicide, and the vegetation, instead of doing its work in an orderly way, becomes rampant and unmanageable. Instead of a velvet-like growth of minute algæ on the rock-work, involved ropes of confervæ appear, or, what is worse, the water becomes opaque with "green stuff;" there are more spores set free than can find resting-places, and they float in the liquid, and make it of the consistence of pea-soup. Light alone must not have all the blame, for heat is also a powerful agent to bring about such a state of things. It is evident, therefore, that the heavier is the vessel in bulk, proportioned to its size, the more slowly will it be affected by heat; a heavy non-conducting opaque material should largely predominate in the construction of the tank, and nothing has hitherto been found so suitable as slate. The lighter and more fully illuminated the vessel, the less is its value for marine purposes; it must be heavy, and but partially open to the effect of light, and then an equable temperature is obtained, and a more constantly pellucid state of the water. Mr. Warington's name has been mentioned in the former part of this work as having done much for the Aquarium. He must have honourable mention here again as the inventor of the slope-back tank, which realises the conditions of success more completely than has been accomplished by any and every other means.

SLOPE-BACK TANKS.

The object sought to be accomplished by this form of vessel is a closer imitation of the conditions under

which marine animals exist in their native waters. *There* the light which reaches them is wholly vertical, or at least the laterally-refracted rays are but of small account. In the slope-back tank the back and ends are of an opaque material, and light is admitted from above only, so that the tank is in itself the closest possible imitation of a rock-pool, with the advantage of affording an uninterrupted view of the contents. The form in which these tanks were originally made is shewn in the annexed cut, and with such vessels I have had such



unvaried success, that from my first adoption of them I have constantly recommended them as the best for marine purposes. It is true that able pens have denounced them as ugly and unmanageable, but the day of their disgrace is nearly over; many who opposed them are now glad to have their aid, after paying heavy penalties in the use of tanks made wholly of glass, and after the shallow square tanks and the glass pans, these are certainly the next in efficiency; and, so far from being inelegant, nothing in the way of aquaria can surpass or even equal the beauty of the scene they present when well stocked, the subdued light being in favour of the view rather than against it. Were it

otherwise the health of the inmates would be a sufficient compensation, for in a matter of this sort it would be absurd to advocate any form of vessel, however elegant, which did not fulfil the conditions essential to the preservation of the creatures.

Let us consider for a moment what are the advantages of this form. Owing to the slope of the back it can be fitted and unfitted more quickly than any other kind of vessel, except the little shallow ones already described. In fitting rock-work, not a particle of cement is needed; hence, instead of losing the whole stock two or three times over, as is the case sometimes when cement has been used, and has been supposed to be properly seasoned, the risk from that danger is reduced to *nil.* Any rough non-metallic mineral may be piled upon the slope in a few minutes, tufts of *Algæ* inserted *à discretion,* and removed again when they decay, without the smallest disturbance of the general furniture. Better still, the most beautiful and appropriate back-ground may be made up of old serpula, oyster, and other shells, blocks of coral, and such light rough *debris* as will be sure to accumulate in the hands of an aquarian. Oyster shells incrusted with serpulæ, balanæ, and other small marine masons, add nothing to the weight of the vessel, yet serve all the purpose of heavy rock-work, and if the spontaneous vegetation so necessary to the success of the tank does not appear on them with sufficient profusion, a few pieces of mica-schist may be mixed with them and left alone, and there will soon be plenty.

Another advantage of these tanks is their strength. When properly made they will last a lifetime without becoming leaky, which cannot be said of any tank having four sides of glass. Perhaps four-fifths of the glass tanks made and sold at the first start of the

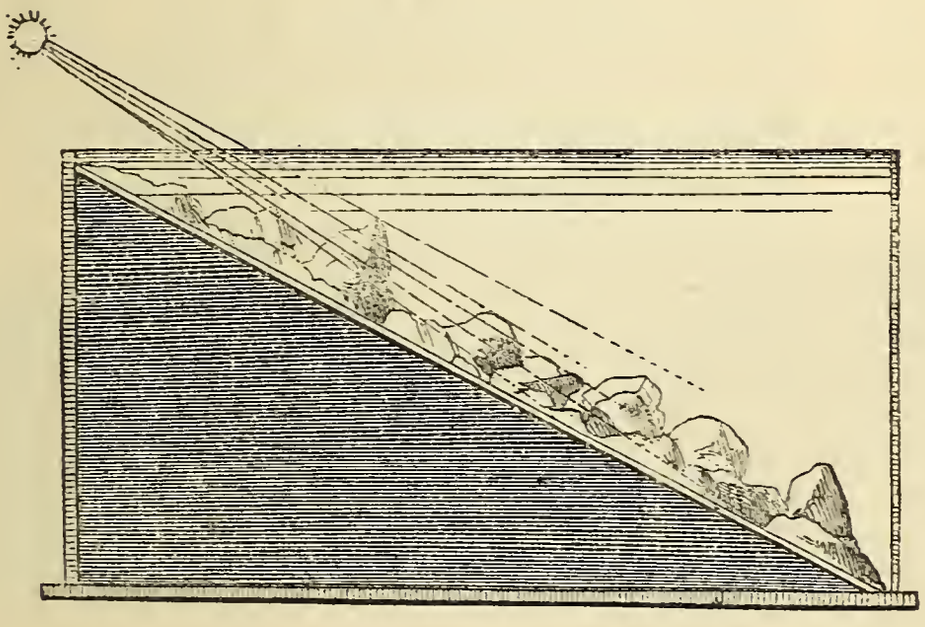
Aquarium are now in lumber-rooms inhabited by spiders, and the majority of their owners have given up aquarian pursuits, under an impression that the construction of water-tight tanks is an impossibility. That the impression is an erroneous one the process of uniting the joints patented by Mr. Lloyd, sufficiently disproves, but on the old plan of letting the glass into a simple groove, the Warington tank, having three sides of slate, can be made sufficiently sound to endure a lifetime.

A still more important advantage of the slope-back tank is the equable temperature of the water within it. Even if the sun's rays be allowed to play on the back of the vessel—which they should not—there is so large a bulk of slate for them to heat before the water can be effected, that there are no sudden changes of temperature to destroy the lives of the inmates. The tanks of this sort are therefore essentially *cool*, and during the trying months of July and August marine animals will endure the heat with patience, when, in any vessel having glass sides, they would be perishing at the rate perhaps of half-a-dozen per diem.

SLOPE-BACK WATER-CHAMBER TANKS.

But the improvements effected by Mr. Lloyd have rendered this form of vessel still more acceptable than it was originally. On the principle that the larger the bulk of water the greater the variety of creatures that may be preserved in it, Mr. Lloyd has adopted a form by which the triangular space under the sloping back converted into a water-chamber, communicating with the space in front. Into this chamber none of the animals can find access, and in one sense the bulk of water it contains may be regarded as a reserve, the

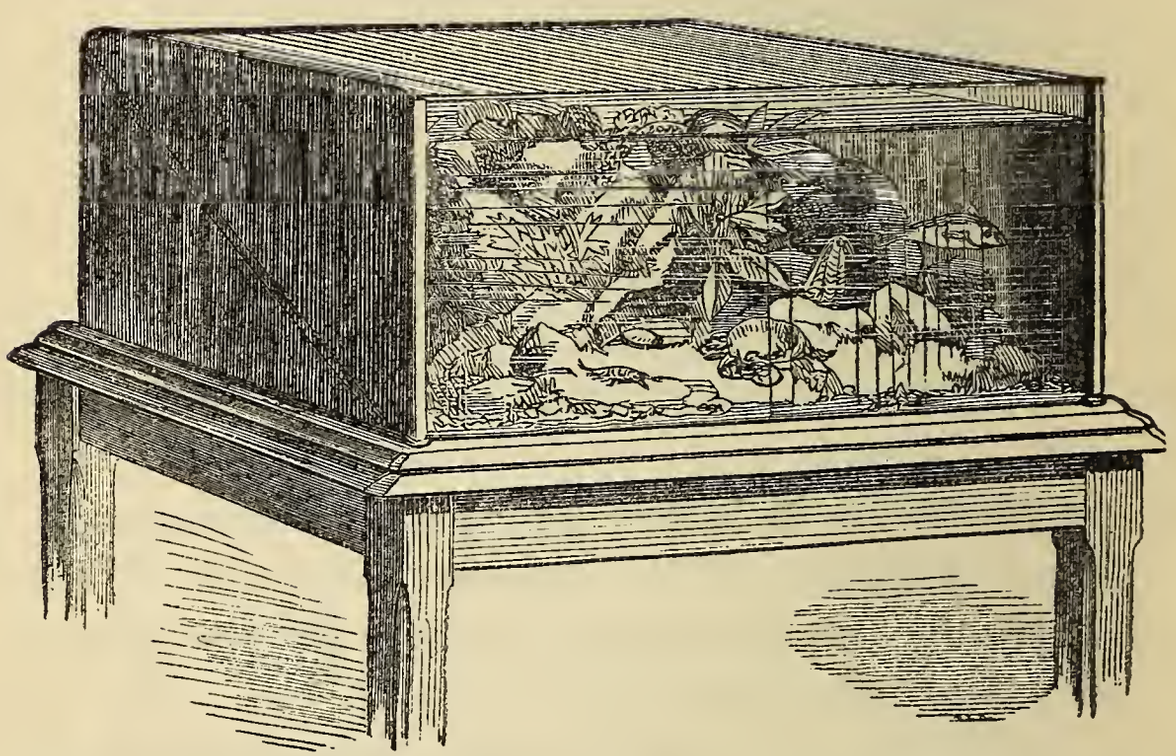
whole of which can be pumped into the tank proper whenever, by the death of an animal or other causes, the water there has become impure. A farther advantage of the water-chamber, in addition to the increased resistance to changes of temperature, which the increased bulk of water offers, is the rapid restoration to purity which the water undergoes in it, and the obliteration in the course of a few hours of that peculiar malady



of the marine tank, known as "pea-soup greenness,"—the result generally of the too free admission of solar light. Should the tank become cloudy by the presence of an excess of microscopic sporules, the whole can be changed from the light to the dark chamber, and vice versâ, by the action of a small pump, and thus, in case of any accident, there is a reserve of fresh sea-water ready, without fetching or carrying, in the body of the tank itself. Being comparatively shallow as to other dimensions there is a large surface exposed to the action of the atmosphere, and by adding a glass cover, to be raised or lowered by means of a cord and pulley, all the conditions of success are ensured by the simplest possible arrangements.

TANKS FOR MOLLUSKS.

For special purposes other forms of tanks are used. It is not advisable, for instance, to associate together mollusks and actiniæ, and instead of the slope-back tank, which is unequalled for the latter, the former are most conveniently preserved in shallow octagon tanks, which are fitted with rock-work rising above the surface of the water, so as to allow the creatures to leave the water entirely, and scramble about on the rocks above the surface. If a cover be needed to prevent escape, one of wire gauze fitted on a moveable frame-

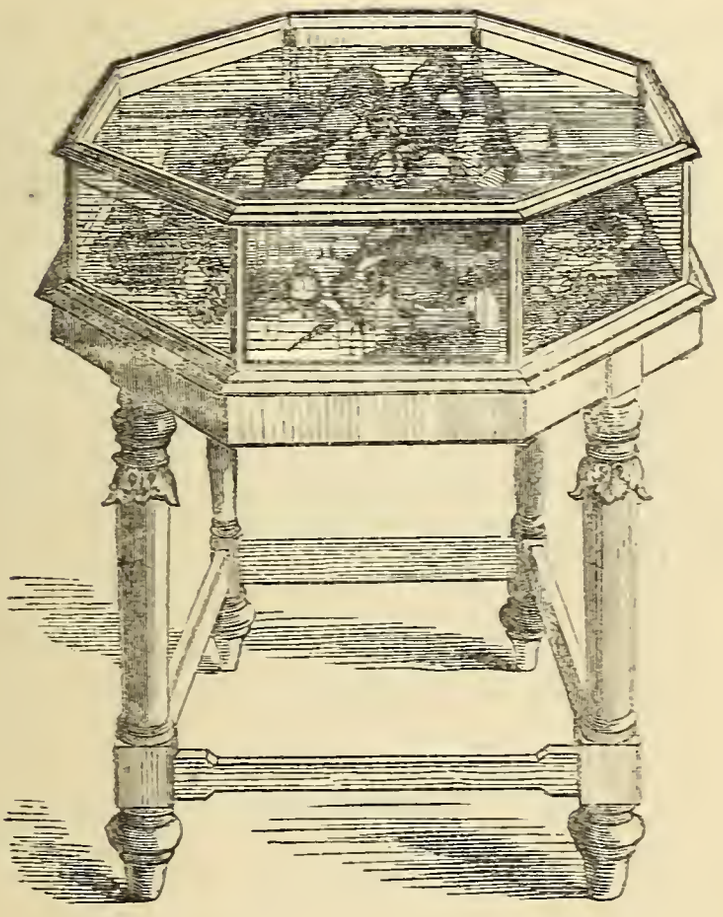


work would be the best. If a glass cover is used it should be in two or more pieces, placed sufficiently far apart to admit air, and raised above the level of the edge of the tank at least a quarter of an inch, so that the air may circulate underneath it.*

* Much valuable information on the construction of tanks, and their adaptability to the several purposes of preserving marine animals in groups, may be obtained by a perusal of the valuable "List of whatever relates to Aquaria," by W. Alford Lloyd, 19, Portland Road, Regent's Park, London, W. It may be obtained through the post for fourteen stamps. No keeper of an Aquarium should be without it.

POINTS IN WHICH THE MARINE DIFFERS FROM THE RIVER TANK.

Though vessels of precisely the same construction are used for marine as well as fresh water aquaria, yet, as the peculiar necessities of marine life demand some conditions of a special kind, I must here again briefly



OCTAGON TANK ON STAND.

treat of the vessels in which marine stock may best be kept. Every variety of tank or vase referred to in the description of the fresh-water Aquarium may be used in the formation of marine collections ; but while vases are eminently suitable for river stock, they are not to be strongly recommended for marine, and for this important reason, that we do not generally have, as in the former case, a variety of moving forms poising

in mid-water, or chasing each other through every part of the tank; but in the present case *ground stock* constitutes the main feature of attraction, and hence we require a vessel which admits of examination in every part, which a *tank* does and a *vase* does not. In a vessel containing actinia, madrepores, serpula, etc., we require to have at all times a clear view of the bottom, and a vase does not admit of this unless we look from above, the amount of refraction being very great at the base of the vessel. Hence, though marine stock may be well kept in vases, it must be borne in mind that such vessels are far inferior as to the means of inspection to rectangular tanks.

It is also important to bear in mind that marine stock invites the use of the microscope in a greater degree than river specimens, and a flat-sided vessel is the only one which affords proper facilities for the application of a magnifier to its contents.

CHAPTER III.

FURNISHING.



HAVE always advised the use of rock-work without cement, and am more than ever convinced that cement should not be used except as a *dernier ressort* in some particular and exceptional case. I lost the whole stock in a tank of forty gallons this spring, through having built up an arch with cement, and put the tank in use again before the saline matter was completely dissolved out of it; yet it had been filled and emptied successively during a fortnight, and the water seemed at last so utterly unaffected, that in a moment of injudicious haste, I set it to work again, and next morning it was a dead-house. Whenever cement is used, let the tank be thoroughly seasoned, and then used for awhile as a fresh-water Aquarium; if an accident happens at the first start it will not be so serious; nevertheless even minnows and dace at sixpence a dozen are not rashly to be housed in a poisonous apartment. If there is any suspicion in the mind of the aquarian that the cement may yet be capable of parting with solvent matter, let him keep it filled with water for another month, rather than hazard the lives of his pets in it.

In using cement, get the best Portland; Roman cement is a miserable dead-looking stuff, and does not set so well under water. Mix but a little of the Portland at a time, and apply it quickly in the form you wish it to

have, as it will neither bear altering while wet, nor can you alter it when dry without breaking the block to pieces. To lessen the weight of a rockery, get a number of clean flower-pots of suitable size, and use them as the basis of the structure, around and on which to build a rough mass. If the rockery is to consist of tall columns, small flower-pots may be worked in all the way to the top, so as to render the column hollow. If the whole of the back of a tank is to be built against, construct the mass of several separate pieces, so that they may be easily lifted out one by one at any time, and replaced with ease. The old-fashioned tanks with four sides of glass may be improved by rendering the back plate of glass opaque by this process; and when all is done, get a sheet of sea-green tissue paper, and cover the back glass with it outside by means of copal varnish, and the interstices between the blocks will be hidden in a most agreeable manner, and one which by reducing the amount of lateral light, benefits the inmates and the general condition of the collection. I have found broken "burrs" from the brick-kilns, such as are used for rock-work in gardens, a very excellent material for large rough rockeries, and especially for darkening the back-plates of the old-fashioned tanks, on which I wasted my money years ago, when we were all in the dark as to the true principles of Aquarium science. The lightest and best-looking pieces of the broken burrs may be cemented round small flower-pots into solid masses of a convenient size and weight for lifting, and may be made tall enough to rise above the water, for crustaceans to gambol over. Cement will not adhere to glass, therefore an arch can be constructed only in a vessel which has ends of slate.

Mr. Lloyd sells a cement expressly for rock-work, which is not affected by sea-water, and does not require long soaking to render it innocuous.

For slope-back tanks empty serpula shells, and old crusted shells of oysters and similar gatherings serve exceedingly well ; small blocks of granite are also suitable, but the best of all materials for marine tanks is mica-schist, as it not only looks well, but is the best of all adapted for the growth of algæ. The merest scrap of confervæ the size of a threepenny piece placed in the tank, will in the course of a week diffuse its spores over the mica, and present a regular growth of vegetation, for a free supply of oxygen. Whatever material be used, take care first to wash and scrub it well—let not a particle of dirt of any kind find its way into the tank. For the bottom sea shingle is certainly the best ; best river shingle will do, or small garden pebbles. Wash them in several waters, stirring them about briskly, pouring the water off, and adding fresh until they are quite bright, and cease to discolour the water used.

SEA-WATER.

In the early days of the Aquarium the use of artificial sea-water was unavoidable, owing to the difficulty of getting supplies from the sea. That difficulty is at an end ; sea-water has become a regular article of commerce, and is supplied fresh, and fresh from the vast tanks at Portland Road, and is forwarded at a low rate of charge to the most remote inland stations by railway. It was never to be expected that an artificial preparation should be equal in value to that obtained from the sea ; nevertheless when it was largely used, it was found of great service, and all the hardy kinds of *Actiniæ* prospered in it when it became thoroughly seasoned by use. It may be that in some remote places possessors of marine animals may find it necessary to prepare sea-water at home, and it would be vain therefore to ignore its uses in such

a work as this. Premising, therefore, that real sea-water is always to be preferred, and that if the animals can be obtained, there cannot be a great difficulty in obtaining with them a supply of water, let us see before us an analysis of it. The composition of sea-water is as follows :—

Water	964.744
Common Salt, or Chloride of Sodium .	27.059
Chloride of Magnesium . . .	3.666
Chloride of Potassium . . .	0.765
Bromide of Magnesium . . .	0.029
Epsom Salts, or Sulphate of Magnesia .	2.295
Gypsum, or Sulphate of Lime . .	1.407
Carbonate of Lime . . .	0.033
Loss, or not accounted for . . .	0.002
	1,000.000

To Mr. Gosse I believe we are indebted for the first hint on the formation of artificial sea-water. In July, 1854, he communicated to the "Annals of Natural History," the results of experiments performed to test the possibility of preserving marine animals in the preparation, and the result was so satisfactory, that for four years subsequently it was largely and successfully used. In the fictitious preparation the component salts were reduced to four, so that no less than three of the original ingredients were dispensed with. If the reader will note in what minute quantities the bromide of magnesium, the sulphate and carbonate of lime occur, and at the same time bear in mind that river and spring waters always contain a considerable proportion of the last-mentioned ingredient, it will be easily understood that the absence of those materials in the preparation does not materially affect its value. The preparation on Mr. Gosse's plan is composed as follows :—

Common Table Salt	3½ ounces.
Epsom Salts	¼ "
Chloride of Magnesium	200 grains, Troy.
Chloride of Potassium	40 " "

The recipe may be given in another form to avoid the perplexity of avoirdupois and troy weights, thus :—

Common Salt	81 parts.
Epsom Salts	7 "
Chloride of Magnesium	10 "
Chloride of Potassium	2 "

There are also other preparations respectively known as Hains's, Warington's, and Brew and Schweitzer's; the latter is obtained by the evaporation of sea-water to dryness.

MANAGEMENT OF ARTIFICIAL WATER.

When the salts are ready, it is best to mix them in an earthen pan or jar, and allow them to settle and refine for a day or two. To dissolve them in the tank is decidedly a bad plan, though it is daily recommended by the dealers. Any one who will dissolve a portion in a clean bell-glass, and allow it to stand for a week, using the clearest water, and adding nothing but the salts, will observe, at the end of that time, a quantity of gritty deposit, similar to iron rust, mixed with minute fragments of sand. This deposit proves that the chemicals we obtain are not pure; and, perhaps, it is not desirable that excessive purity should be obtained, but it certainly is desirable to keep such matters out of the tank. When the salts have been stirred up once or twice, so as to dissolve them thoroughly, test them for the last time with the hydrometer, till it registers 1.027 or thereabouts; it may safely range from 1.026 to 1.028

without interfering with the success of the experiment. Hydrometers, registered for sea-water, are not everywhere obtainable, and the specific gravity bulb, sold for a shilling, answers the purpose just as well.

A CAUTION TO THE UNINITIATED.

Some beginners have attempted the preservation of marine specimens in solutions of common bay-salt, and have expressed surprise that they perish rapidly in a solution of salt obtained *from the sea.* Anyone at all acquainted with chemistry would readily predict, that there could be no more certain way of killing the creatures than the adoption of such a plan of preserving them. When bay-salt is prepared, many of the more soluble materials, chloride of magnesium especially, remain behind in the mother liquor, because the chloride of sodium crystallizes first, hence *bay-salt alone does not produce sea-water;* we must have the aid of the experienced chemist, or turn chemists and prepare it for ourselves.

Those not experienced in chemical manipulations may find some difficulty in obtaining and weighing accurately the several ingredients; and I should advise them to purchase the preparation as sold for the purpose.

FILTERING.

When the salts are well mingled with the water, pass the liquid through a filter into the tank, which is supposed to have been already well seasoned, and furnished with a bottom of sand and pebbles, and any ornaments that may be deemed necessary. A bee-glass, with a bit of sponge thrust into the orifice, is a convenient form of filter, but if such a thing is not at hand, take an *old*

flower-pot, and wash it quite clean, thrust a piece of sponge through the hole in the bottom, and throw into it a handful of powdered charcoal. This may be suspended above the tank, or stood on two slips of wood, and filled from time to time, till the whole of the water has been passed through it.

Some healthy plants of *Ulva latissima* and *Enteromorpha compressa* are now to be introduced, and the whole left undisturbed for at least a week or ten days when the stocking with animal life may commence; some of the hardy *Actinia* being the best of all to start with. But if the aquarian is in a fever to see something alive in the new vessel, he may drop in two or three *Actinia mesembryanthemum*, one day after the introduction of the plants, and unless he has made some mistake in the preliminaries they will do well. Indeed, on emergencies this species may be kept alive for a week in soap-suds, and even in more offensive liquids; and judging by the life the creature leads on the sea-shore, now submerged in the cool waters, and now exposed to the burning sun, it is not surprising that it has a hardy constitution. Still, this hasty proceeding is not to be recommended; let time develope the powers of the water, let uninterrupted vertical day-light reach the plants, and soon a lovely beading of oxygen bubbles will appear, to indicate that all is right, and *then* the animals may follow each other in proper order to their domestic home.

If a little real sea-water, or even a pint or two, can be obtained to mix with the artificial, the ripening of the latter will be considerably hastened, but it is an interesting fact in the chemistry of the Aquarium, that, though in the first preparation of sea-water certain of the ingredients are left out of the prescription, in process of time those very same ingredients are to be discovered in it by means of analysis. How do they get there? They are com-

municated to it by the vegetation, and hence as the water acquires age, like good wine, it increases in strength, and after some months use, will maintain creatures in health that would perish in a day in water recently prepared. The preparation costs only fourpence per gallon, or a three-gallon packet for one shilling.

SEA-WATER,

Of course, may be obtained direct from the sea, and should, if possible, be dipped in mid-channel. Shore water is not altogether objectionable, for where we find the greater part of our specimens it is evident the water must be suitable for them. In fact, I have found water that I have brought from the sea-side in jars serve just as well as that supplied by the steamer from the open sea; but near the mouth of a river it would be found unsuitable, as it would, also, from any parts of the coast where land-springs abound. Earthenware vessels are the best for the conveyance of sea-water and specimens, but if a large quantity be required, a new cask should be used, and the greatest care taken to have it stopped with a new bung, and conveyed quickly to its destination. Mr. Gosse recommends a cask of fir-wood if it can be procured, "the wood of the oak, of which wine casks are usually made, gives out *tannin* or *gallic acid* to the contained water, which by its astringency, converts the animal integuments into leather." In fact, our poor anemones get their hides tanned if any vegetable bitter comes into contact with the water in which they are to be kept. I make it a rule to filter sea-water through charcoal before using it; this is not essential if the water appears bright, but is, at least, a precautionary process that may have its advantages.

SUMMARY OF GENERAL PRINCIPLES.

Whatever the form of the vessel used, and whatever the style of preparation as to arches, rocks, etc., these points should be borne in mind as of the first importance. The larger the bulk of water the longer will it resist the effects of heat in summer and frost in winter; the more equable in fact will be its temperature, and the greater the number of animals that may be preserved in it. It follows, therefore, that the smaller the vessel, the more care must be used during seasons of extreme heat or cold.

The degree of success will be proportioned to the relative amount of surface exposed to the atmosphere; in deep vessels the zoophytes are apt to get down out of the reach of atmospheric oxygen. In shallow vessels there is such a rapid absorption that they are rendered almost independent of the supply furnished by vegetation; nevertheless vegetation is necessary both for the maintenance of the balance, as well as for completing the beauty of the scene.

The degree of success will also in a large measure depend on the amount of light admitted to the vessel. A powerful sunshine will cause the excessive development of minute vegetation, and too little light will cause a cessation of the supply of oxygen. In a south or east window, there will be most risk of danger from excess of light, and the window should be furnished with a Spanish blind outside, as well as a white roller blind inside, as on a burning hot day in July it may be necessary to use both for a few hours. Darkness is death, light from all sides is injurious, modified light through the surface of the water is exactly what we

want, as an imitation of the manner in which the sea is illuminated.

The range of the temperature in the ocean is from 45° to 65° of Fahrenheit's scale. We may therefore set down the minimum temperature in winter at 45°, and the maximum in summer at 60°. When it rises beyond the last-named point is the beginning of danger ; at 70° the danger is imminent, at 75° *Dianthus* lets go his hold, *Troglodytes* closes, *Bellis* dies outright. Another rise of 5° will probably make an end of the collection. These facts should be thought of in choosing a place for a marine tank, as also in determining at first what sort of a tank is to be used. It is astonishing how a heavy tank largely composed of slate resists sudden changes of temperature, and remains cool throughout the hottest day, especially if the window is kept open, the blinds down till sunset, and a light draught over it from the window left ajar all night.

CHAPTER IV.

It is the sea, it is the sea,
In all its vague immensity,
 Fading and darkening in the distance!
Silent, majestical, and slow,
The white ships haunt it to and fro,
With all their ghostly sails unfurled,
As phantoms from another world
 Haunt the dim confines of existence.
LONGFELLOW'S GOLDEN LEGEND.

SEA-SIDE COLLECTING.



HE most pleasurable task in forming a Marine Aquarium is that of stocking it with specimens. Here is the sweet necessity of pleasant railway and steam-boat trips through miles of waving corn-fields, green hedge-rows, and fertile flats, or along the course of the winding Thames, away out of the smoke and din, to burrow, if we will, like rabbits in the sand. The true lover of nature will collect his specimens rather than purchase them, and will learn many lessons of the minute completeness of the Great Design of Creation, as he probes among the clefts of rocks, or searches the tide-washed sand, or assists in the exhilarating work of dredging the deep water. There stretches the bright beach that blinds the eyes with its glare of straw-colour, as the sun blazes alike over sea and sand,

and snowy cliff, and towering moorland. The sand hillocks are phosphorescent in their sunny glories, and wherever the eye catches sight of a patch of purple heather on the upland, it has the brightness and isolation of a jet of subterranean fire. The touch of brown on the ferns and peats that fringe the slopes towards the sea, add to the intensity of the colouring; and, before the bright panorama, rolls the majestic sea,—in sheets of azure blue and emerald green, flecked here and there with snowflakes, and dashed with broad shadows from the clouds and the distant rocks,—which, with all its fret of breakers, and the sublime muttering of the surf along the shore in its expansive vastness, conveys the idea of a grand and everlasting repose. It is

> "Of the Invisible; even from out thy slime
> The monsters of the deep are made."

If by "monsters" Byron implies things of huge life and growth, then it is not for such we find our way to the sands. But "the slime" is wealthy in wonders; it is all life; every gritty edge swarms with myriads of creatures, every frond of algæ is peopled, and, among the fissures of the honey-combed rocks near the shore, and far out to the depth of the lowest tide, the hand and the eye may busy themselves with the inhabitants of Neptune's kingdom, and make acquaintance with creatures that have their place and their work in the grand economy of the omnipotent Master of the Sea. The sea is His, and He has given man command over its creatures for sustenance, for instruction, and for records of His wisdom and His will. We may find less profitable pleasures than those of exploring among the shifting pebbles and slippery meadows of sea-weed, the tracing of God's handwriting on the bottom of the sea.

The requisites for collecting on the beach are, a geological hammer, a strong chisel tipped with steel, a neat hand-net, a large closely-woven covered basket, two stone jars, one glass jar, or a confectioner's show-glass, and two or three small phials. The vessels must be quite clean, not the least taint of any chemical ingredient, or even of stale sea-weed or water in them, if new the better; in addition to these it is well to have a pair of stout water-boots for wading into pools, or for protection against the running surf, the best specimens being found at lowest ebb, below the water-line. If you take an attendant, let him put a small crow-bar on his shoulder, and swing the basket on it. Lady-collectors will of course dispense with the boots, and obtain the help of the gallants in exploring the half-fathom depth.

The best season is during summer and autumn, just after new or full moon, when the tide recedes to its greatest extent, and lays bare large tracts of surface, which are at other times covered by the sea. The sea-weeds that are washed on shore are useless, and it is waste of time to collect any however tempting their appearance. We must have them in their fullness of life, fresh from the sites whereon they grow. The best hunting-grounds are the ledges of rock that run out to sea, and which have the full play of the sea currents till the tide is nearly out. Between rolled boulders and in deep hollows, and indeed any rocky shelves that are not bared till lowest ebb, and above all, the "tide pools" which abound in rocky situations.

If you want to study marine zoology at the sea-side, go not to fashionable promenades. The broad shallows where fashion finds its pleasure, and novices take their daily strolls, are just the spots that are poorest in natural history. The best marine hunting-grounds are the deep inlets where the tide leaves some water even

at ebb, and where the shore is made up of tumbled rocks and quiet hollows; and, though there is sometimes a little danger in venturing too boldly on such spots, a quick eye will be pretty sure to detect some sort of beaten path to the water's edge, and to the best of rock-pools. It is in such quiet, splashy nooks, that the most valued treasures are cast up, and preserved within reach; whereas, on the sloping sands there is little to be found beyond mere drift, of no value.

Now you are off. The tide is out, and if it is the time of spring tide, your chances are doubled, for then a greater space is left bare, and many true pelagics may be met with among the lowest of the ledges. Peep into the first pool you come to, and you will see nothing. But wait a minute and be quiet, and a rippling of the surface will advise you that the creatures have got over their alarm. After a few seconds dip your hand-net quickly, and ten to one you have a prawn or two, a blenny, a stickleback, or a goby. Fill one of your jars quickly, and empty the contents of the net into it, and then wait again. Next time a soldier crab may come out from under a ledge; if so, bag him by a dexterous dip of the net; but be in no hurry to handle him, or you may bleed. When there seems no more chance of catching lively creatures, begin to hunt for the more torpid kinds. You will see, perhaps, a little beach of fine pebbles at the bottom of the pool, and no sign of life anywhere amongst it. Pass your hand rather deeply into it, and bring forth a good handful, and turn it out on the nearest flat stone; ten to one you will find one or two sea flowers that had made themselves jackets of the grit, and so hid in ambush. The lovely *Crassicornis* or coriaceous anemone loves to hide in this way, entirely covered with a coat of pebbles; but after a short stay in the

Aquarium he shakes them off, and comes out in his true colours, a "gem of the sea." Next, lift up the banners of algæ, and examine their under sides for other sea flowers; and, as you meet with specimens, break away the frond to which they are attached, rather than handle the creatures. If fixed on the rock, defer attempting to remove them till you have obtained as many as can be got without using the chisel. Among the oyster-shells, bits of tile, and glass bottles, often found in these hollows, you are pretty sure to find anemones, and in every such case take them as they are, without attempting their removal from the nidus. Last of all, determine among those that are attached to the rocks which you intend to have. If you can, by a smart blow with hammer and chisel, detach a fragment with the creatures on it, you will have gained a prize, because they have a tenfold chance of prospering afterwards, if never touched by the hand. But it may be impossible, even by working under water to break away the part you want; the last resource to detach them is sleight of hand. Bear in mind the classical story that Hercules is vulnerable in the heel, and you must be particularly careful not to rupture the base of an anemone. Gather your fingers round the stem, so as to enclose the whole of it, the touch will cause it to contract so as to be easier of handling. Then work the thumb-nail under one side of the base, and loosen it from its foothold steadily, and without any tearing or jerking. It tries your patience, but it loosens, lets go, and at last you have it. Drop it into the vessel, and waste not a moment; one jar will hold a vast quantity, and the creatures will not fight nor injure each other till their alarm is over. Before you finish that particular pool select your marine plants. Get as many tufts of *Ulva* and *Enteromorpha* as you

can; every one must be on a piece of its native rock, or it will soon perish. Bright green, and bright red algæ are always useful; but brown, purple, and olive-coloured kinds are of little use, except as botanical specimens. *Rhodymenia palmata* and *Delesseria sanguinea*, are lovely things, which you may meet with in pools at the lowest water-line; if you cannot easily detach them, cut them off close at the base; and, if bound to a stone and thrown into a tank, they will live some weeks, to be removed as soon as they shew signs of decay. This is a pretty and instructive way of using many other kinds which it is difficult to get complete. A frond of *Nitophyllum punctatum* is a fine ornament; and a tuft of *Griffithsia*, and a single leaf of the Ladies' Tresses, *Laminaria phyllitidis*, are two other subjects suited for the same use. When you have despoiled the pool of its treasures, pull away a handful of fresh sea-weed of any kind, and lay at the bottom of the basket. Place the plant specimens on it, and cover with a little more, and then hie away to another spot.



RHODYMENIA PALMATA.

You will of course get many things which you will afterwards have to throw away, but that is better than the loss of a choice specimen. In little wet hollows

will be seen what appear to the unpracticed eye like round pieces of red flesh, of the size of a chesnut, or larger; these are anemones, the best of all things for a tank. A beginner will not easily remove these, therefore the chisel and hammer must be brought into use, and the portion of stone broken off. A little practice, however, will enable any one to remove an anemone by slipping the finger nail or a pewter spoon under them.

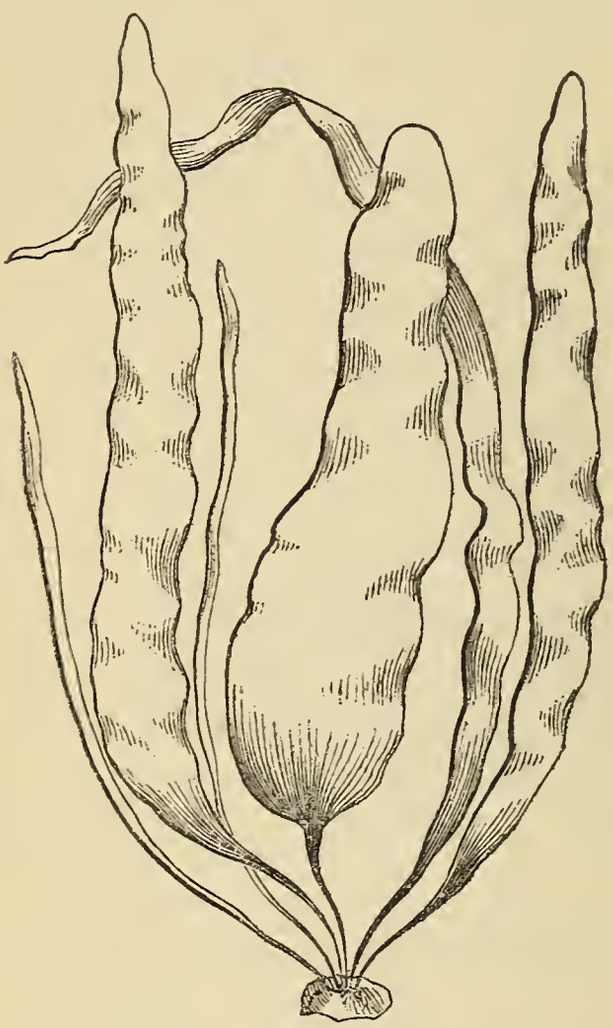
Sometimes half-a-dozen of the common smooth anemone



DELESSERIA SANGUINEA.

may be obtained from one splinter; and it would be an unusually unprofitable search that did not result in the capture of many other kinds of sea-anemones. The dark lovely sea-grass *(Zostera)*, will be found waving in the pools; and by tucking up the sleeves, and working either on your knees above the hollow, or standing in it according to its depth, you may secure some tufts attached to portions of rock. It is useless to tear any weed away from its hold, if you cannot splinter off the rock on which it grows. You will often be vexed at the snapping asunder of a specimen at the first blow,

for the algæ have no proper root, and keep possession by a very frail tenure. Poring about the water's edge, you will doubtless meet with many shelly substances adhering like little grey cornucopiæ, or twisted tubes, to such surfaces as are constantly submerged. Sometimes these are found in little colonies under boulders and wet ledges. These are *serpulæ*, and must be prized as worthy of preservation; these must be tenderly detached, as they adhere only at the tip of the tube. In the quiet pools some small fishes may be taken with the hand-net by a little dexterity. Blennies are particularly valuable, the little shanny *(Blennius pholis,)* and the butterfly blenny, *(B. ocellarus,)* are both lively amusing creatures, and bear confinement in the tank with most happy submission. The collector who has not had some experience will be tempted to bag some specimens of oar-weed, *(Laminaria)*, on account of their attractive appearance: these have long puckered dark brown fronds. They are, however, useless, for they soon perish in confinement, and render the water turbid with their putrescence. The tangle is equally objectionable; this grows with the oar-weed. It has broad smooth leathery fronds, of a deeper colour than the oar-weed; the fronds start from a slender stalk, and the older speci-



LAMINARIA FASCIA.

mens are seen to be split into jagged segments like fingers, hence its name of tangle.

In the quiet pools several choice plants may be found just below the surface, and amongst them some nimble fishes. To capture the latter is no easy task. The foot-fall alarms them, and away they dart in shoals. Any that can be captured with the hand-net, must be secured, and you may be lucky enough to find yourself in possession of a small collection of gobies and blennies, and by probing the sand you may take some specimens of the silvery lance, *(Ammodytes,)* which burrows on the retreat of the tide. The flat fish found in the mud and sand are useless; the brill, dab, sole, and plaice, and now and then a young thornback, may be found, but as all these burrow, and lead a lazy life, it is folly to give them room in the tank. Beside which they do not thrive there, and should they die unseen, will taint the water and perhaps destroy the whole stock before the cause of the disaster is discovered. In these spots you will find that best of plants, the sea-lettuce, *(Ulva latissima,)* which thrives so luxuriantly in the Aquarium, and forms fairy-like waving arches, through which the lively fishes delight to dart and gambol. It is abundant in the wet hollows, and runs up quite to tide mark, so as to be almost uncovered at low water. It has a delicate green hue, and is usually much crumbled and torn at the edges. This and the grass-like Algæ, *Enteromorpha compressa*, should be obtained in plenty, the blocks being carefully broken off, so as to avoid injury to the plants. They are the best of plants for all early experiments, without them no progress can be made in preparing artificial sea-water for Aquarian purposes. Another useful plant may generally be found in company with these, the *Cladophora rupestris*. It is of a darker green, consisting of many jointed threads which grow into dense

tufts. All these are difficult to remove, and useless if broken from their site. The collector must therefore persevere until he can break off a fragment of the rock bearing the plant uninjured, or till the returning tide drives him back to terra-firma, a disappointed fisherman.

The stony corallines should be sought for in these pools. They will be found incrusting the stones, much in the same way as the grey lichens coat the stones and old timber in damp moors. This coralline (*Corallina officinalis*,) puts out a number of jointed purplish shelly growths, and adheres firmly to the vertical surfaces on which it is produced, each patch of it spreading in circular bands. The mature growth of this coralline resembles in form minute twigs of yew-tree, and they spread into arborescent tufts, and hang over the edges gracefully. The young purple shoots should be chosen, and a piece of rock well covered broken off. It suits well for the tank, and lives a long time. White ones are useless; they are in a state of incipient decay, and soon perish.



CORALLINA OFFICINALIS.

Two other forms, allied to *Corallina officinalis*, are useful. One is the slender *Jania rubens*, a delicate hair-like coralline, somewhat resembling the small mare's tail of the hedges, the other is *Melobesia calcarea*. Both of these will be found in the same situation as the coralline just described, and must be transferred with a splinter of the rock or the sea-weed base on which they grow.

Amongst the shore mollusks the most abundant are

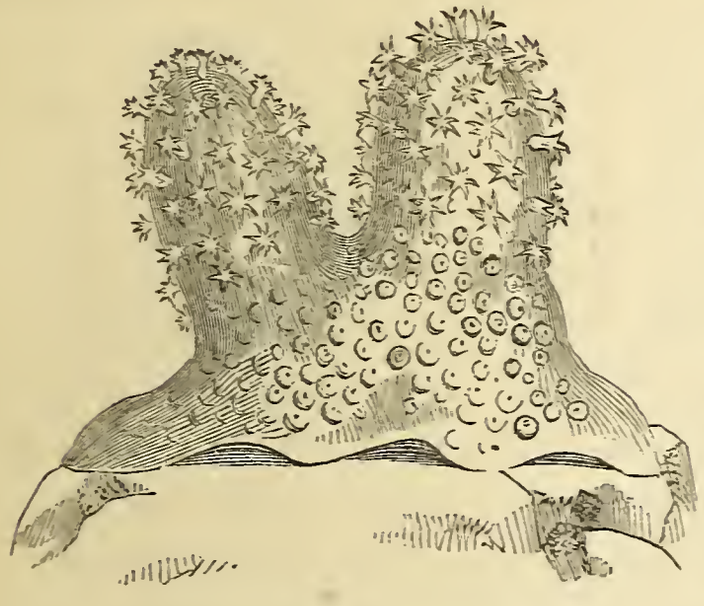
the common winkle, and the rarer kinds of winkle, marked with yellow, black, and brown hues. A number of these may be gathered of any kinds that occur; they can afterwards be got rid of should you possess more than you want. The least useful of the tribe is the little yellow winkle, *(Littorina littoralis.)* The well-known mollusk called top, *(Trochus,)* is very abundant in the hollows tenanted by the periwinkle. They may be known in a moment by any one, however unacquainted with marine zoology, by their neat conical shells, spirally banded, and terminating in a beautiful point, not altogether unlike the amber snail of the hedges, but less globose. *Trocus cinerarius*, *T. Zizyphinus*, and *T. umbilicatus*, are the most abundant kinds. Prawns, shrimps, sandworms, and crabs, are to be secured as they occur; they may afterwards be sorted, and the least attractive thrown away. Many useful mollusks, such as the pretty doris, one of the naked mollusks frequently found underneath water, and in appearance very similar to a grey slug; the cowry, in its porcelain and delicately-painted shell; the murex, the purple, and chitons, are easily found in searching the rocky portions of the sea-beach.

The habit of a true naturalist is to look at the ground on which he treads, just as Frenchmen say of an Englishman that he is always looking at his boots. Do not hurry on in any vague hope of meeting with a shoal of anemones, but scrutinise, as you go, the cracks and fissures; and wherever there is a thick fringe of algæ or even a heap of drift, stoop down and make an examination. If not used to shore hunting, depend upon it you have already passed by many a treasure that an experienced eye would have detected. When left by the tide, the sea-flowers no longer disport themselves like radiant stars, but shrink up into button covers, and are often barely perceptible, even when immediately under

the eye. Vertical planes are those they most prefer, and it is on the sides, rather than the upper surfaces of the wet rocks, that the search must be directed. Suppose you come to a small escarpment, jagged and slippery, and with numerous overhanging ledges, there you will be sure to find booty. Higher up you are almost sure to find hundreds of the common strawberry anemone, looking like so many chesnuts put to roast in the sun. Do not overload your vessels with these—the temptation is great, because of their abundance and beauty when expanded; but, on the other hand, do not despise them because they are so common, for they are the hardiest of all their race, and present a great variety of colours—crimson, vermilion, brown, green, and olive.

As you get towards the lowest ebb of the tide, your gatherings will increase in value. You may even meet with the grand *Dianthus*, and the curious *Anguicoma*, cast up into a hollow, and there blooming in their full lustre like coronals of true ocean flowers. The daisy is another sometimes so found, and the best of it is, that in such positions, having been recently deposited in such sites, they are generally attached to small stones and shells; sometimes a large parent, surrounded by a dozen little ones, all removable without injury, on the shell to which they have affixed themselves. More crabs will turn up, and if you catch sight of any apparently empty winkle and whelk shells, take them out, and see if they are not inhabited by hermits, a few of which are most acceptable, as contributing to the variety of the gathering. You can scarcely expect to find *Serpulæ*, but after a storm they are to be found at low-water mark; the sign of their presence is a large whelk or oyster-shell, covered with their convolved tubes. Though the footfall may cause the creatures to ensconce themselves closely, you have only to look inside the tubes for a scarlet disc,

and you may be sure you have a living specimen. *Terebellas* are plentiful in rough blocks of soft sandstone, and among fragments of chalk and limestone the wonderful *Pholas* may be found lurking. Here, too, you may meet with that curious example of marine life called "Dead Man's Fingers," (*Alcyonium digitatum*,) a soft, fleshy mass of *Polypes*, by no means tempting to the fingers, when exposed to air and sun, but which, when placed in a vessel of sea-water, reveals its true character, as a community of creatures adhering together to one common base. It does not live long in the Aquarium.



ALCYONIUM DIGITATUM.

It is well to know what to avoid, as well as what to secure. Barnacles are of little use—muscles and limpets must not be gathered in quantity ; most univalve mollusks are apt to die, aud cause a black putrescence, especially when under the care of beginners. *Crassicornis* is a tender creature, and can only be kept for any length of time by adepts. I do, however, know of many aquarians who deny the difficulty, and could name instances of its living in the same tank for more than two years, and producing young. I had a birth myself this spring, but the parent died a few days afterwards. That it is not the best *Actinia* for beginners is evidenced by the fact, that Mr. Lloyd refuses to sell it, in order that its death may bring no blame upon him. A specimen measuring five inches across the disc, which I brought from Bournemouth last autumn, lived four months ; but it had

a vessel to itself, and was plentifully fed. Avoid all the coarse tangle and sea drift, such as *Fucus*, *Laminaria digitata*, *etc.*, except for purposes of packing; for this they are acceptable.

In this, as in all other pursuits, the pleasure increases with the growth of experience, and skill once acquired, every visit to the shore will reveal new forms of beauty and wonder. The beginner will have to guard against two kinds of accident. He may wander out by means of a stretch of sand, or a group of boulders and jagged masses of rock, and when far from the mainland, be overtaken by the tide. I shall never forget having to swim for it when caught in this way, while examining a cave called the fairy's kettle, under a cliff at Tynemouth, and, in the case we are considering, the collection as well as the collector may be in danger of a ducking —possibly something worse. Haunters of the sea-side are generally pretty cautious and watchful of tide-tables, but in the abstraction of mind from surrounding circumstances which accompanies sport of all kinds, the precaution of watching for the turn of the tide may be forgotten. The other danger arises from the nature of the surface on which you tread. Sand is safe enough for the veriest cripple, but the weedy surface of a slanting block of stone, or the tuberculated crust of a well-covered boulder, may prove a slippery foot-hold, and help you into a deeper pool than you desire to fish in.

It is no pleasant matter to lose one's footing, or even sometimes to keep it when a fierce breeze blows off sea, and sends its "white horses" prancing over the beach, soaking you if you will persevere, and frightening you if you stand aloof. The naturalist must encounter a few perils, and he does encounter them boldly, and with little regard to such a trifling matter as a grazed shin or an impromptu bath; but it is not to be expected that

all who commence the study of nature at the sea-side, will care to encounter the perils which an experienced student thinks lightly of.

When the return of the tide puts a stop to gathering, is the time to think of packing-up. The specimens must be arranged for transport as soon as the returning tide warns you to quit. You will find yourself in possession of an assemblage of objects of most opposite character, some slimy and half-dead, others so lively that you have every chance of losing them, unless you exercise some caution, while others are so fragile in texture that it seems dangerous to touch them. Sort over your jars, and arrange your stock, as far as you can, in classes. Mollusks will carry best in water, if they are to go any distance ; but, if the transit is to be soon over, they may be packed in wet sea-weed in the basket. Crabs may be packed in the same way, except hermits ; they must go in fresh-dipped sea-water, and as few together as possible, for fear they should get up a fight. If you should have had the good luck to meet with a hermit, with a parasite anemone on the shell, give him a jar to himself, with a tuft of algæ. In turning out the *Actiniæ*, those that have attached themselves inside the jars must not be disturbed. Let them remain there till you get home, when you can either detach them, or break the jar, and place the fragment on which the creature is fixed in the tank, so as to do away with any necessity for handling it. In this way the gatherings may remain for forty-eight hours without danger, but it is not advisable to keep them so confined any longer than is absolutely necessary. In the final arrangements for carriage, see that the blocks of stone are so arranged that they cannot jostle about, and that they do not press on any of the creatures. There should be a tuft of waste algæ between every lot of animals ; before leaving

the shore the basket should be dipped into sea-water, to drench it through, or at least well sprinkled, to preserve a thorough moisture. Care must be taken that none are injured by pieces of rock, and to avoid excessive pressure do not fill the vessel to the brim. Large stone jars serve well for this purpose. One more hint occurs to me. Avoid any spot on the coast where land springs abound; as in the vicinity of a stream of fresh water but little will be found. But, if you are more enthusiastic than delicate, take care to hunt any dark hollow where the water is foul, and you are pretty sure to find something worthy of search. The finest lot of *Anthea cereus* I ever met with, was in the outlet of a town sewer, where, in the midst of a mass of black sludge, the *Antheas* were expanded like a cluster of blue rosettes. No wonder it may be kept in beer and soap-suds, and even in urine.

The tender sorts of crustacea, sea-worms, jelly fishes, and delicate zoophytes must be placed in sea-water. Mr. Gosse's plan is unquestionably the best that can be adopted for the conveyance of these. He says, "I use wide-mouthed jars of stoneware, with water-tight screwed tops, several of which may be packed in a hamper; at other times a large twelve-gallon zinc pail, protected by a wicker case, with a screw-lid, of which the central part is perforated with minute holes; at others, four small zinc cans, of square form, with perforated tops, fitted into an open box, like case-bottles in a wine-hamper. All of these modes answer well. I know not to which I should give the preference, except that for fishes the large pail is decidedly the best. If heavy stones or oyster-shells, very rich in zoophytes and annelides, be required, a common cabbage-net may be suspended from the lid of the pail in mid-water; the stones or shells being put

into this net, will be kept from injuring themselves or their neighbours, by swinging about the bottom."

Of course the transit must be quickly performed, or many of the specimens will perish. Mail trains and special messengers must be made available, and the moment the stock reaches its destination, the specimens should be carefully sorted over in shallow basins of sea-water, well aerated before the exhausted travellers are dipped out. It is advisable to pour off the whole of the water in which they have performed their transit, but not to throw it away too hurriedly, for if it can be aerated and brought to a fresh condition it may be useful. The real article has this superiority over artificial sea-water, that it contains numerous germs of plants and animals, which afterwards develop themselves, and supply you with home-grown specimens. I have had several good plants presented me in this way, and they have generally started up from a stone that wanted covering to complete the furnishing of the tank, though it is too often the case that these same organic germs rapidly putrify, and cause disorganization of the liquid. Nevertheless it is advisable to husband every drop of sea-water, but be careful to remove your specimens from it when they arrive home, that you may agitate it well for use, or throw it away if too far gone in putrescence.

By sorting your specimens over in bowls, you will get a good view of your possessions, and be enabled to judge of the best modes of disposing of them. You will have a superabundance of some kinds, and a scarcity of others, and sometimes you will find yourself a possessor of many rarities. Where friends can exchange specimens, the respective tanks can be kept well supplied.

Instructions for dredging would be out of place here. It is an operation for a skilled coaster, not for an

amateur. Any one may poke about the sea-shore and hunt for specimens, but he who takes a haul at the dredge for deep-sea wonders, must be somewhat experienced in boating, and otherwise drilled to the work. To dredge with any hope of success requires a knowledge which books cannot furnish.

After all it is most likely that a majority of those who keep Aquaria, will purchase rather than collect their stock. It is a fortunate circumstance that it can be purchased, for we are not all so circumstanced that we can take train whenever the whim suits us, and erratic as crabs, suit our movements to tides, seasons, winds, and changes of the moon.

There are several skilful naturalists now engaged in preparing stock for aquaria. These, true to the genial character of the lover of nature, are willing to give information whenever it is sought, and to aid persons in the stocking of tanks by means of good advice and suitable suggestions. William Thompson, Esq., the eminent naturalist, of Weybridge, keeps a dredge constantly employed, for the purpose of supplying the Zoological Society, and is willing to supply any person desirous of setting up a vivarium. From Weymouth to London the cost of transit by mail train and special messenger amounts only to a few shillings, and a moderate-sized tank of about two feet by one foot, could be stocked with a beautiful variety of animals and plants, at an expense of less than forty shillings. Any one sending for specimens, or making a trip to procure them, should remember the necessity for coral rag for rock-work, and sea-sand for the bottom of the tank. They can be had along with specimens.

To Mr. Lloyd I have already more than once referred, and have only to mention his name here in order to suggest that no one should attempt to set up an

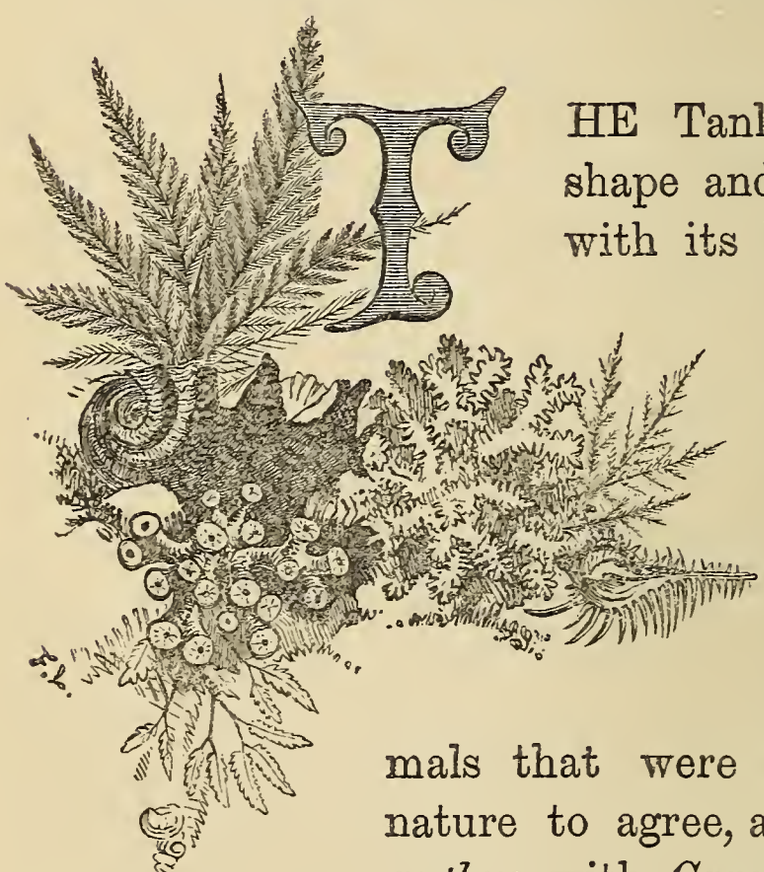
Aquarium without first paying him a visit. He is ready to give counsel as well as to take money, and if the aquarian trusts to his own skill in securing stock, he will, nevertheless, obtain from Mr. Lloyd many little necessaries, such as dipping tubes, thermometers, specific gravity beads, and vessels of all kinds, without a supply of which there can be but little progress in aquarian tactics.

CHAPTER V.

NATURE hath tones of magic deep, and colours iris bright,
And murmurs full of earnest truth, and visions of delight;
'Tis said, "The heart that trusts in her was never yet beguiled,"
But meek and lowly thou must be, and docile as a child.
Then study her with reverence high, and she will give the key,
So shalt thou learn to comprehend the "secrets of the sea."

MARIE J. EWEN.

SELECTING AND GROUPING THE LIVE STOCK.



THE Tank is of the right shape and size; is furnished with its bank of old serpula shells and blocks of mica; now what shall we put in it? The first danger to guard against is *over stocking;* the next danger is the association of animals that were never intended by nature to agree, as, for instance, *Dianthus* with *Carcinus*, or *Pholas* with *Asterina*. Where there are several vessels, appropriate one to *Actinia*, *Madrepores*, *Polyzoa*, and *Chitons;* another to mollusks only, another to such of the fishes as come within the range of our practice, and another to crustaceans, and you will be free of warfare. If you have but one vessel, be content with a few of the most at-

tractive and interesting Zoophytes, and do not crowd it with incongruous gatherings. At any time a glass dish, a pickle bottle, or even a common earthenware soup-plate may be turned to account for a few rare and curious things, of kinds unsuitable for the tank that friends may send you, or that you may collect upon the sea-shore. Crabs crawl over anemones and torment them, and anemones entangle fishes with their barbed threads and destroy them.

Then again there are some animals which agree very well in a general collection, but which for other reasons ought to be kept separate. The beautiful plumose anemone *Sagartia dianthus*, for instance, changes its skin so often that it is continually clouding the vessel with the thin filmy matter, which is sloughed off in the process. It is so fine an ornament, that few will care to be without it, and if it is not preserved by itself, it must be regularly attended to, to remove with a feather or a pair of feeding forceps, as figured in Chapter VII. Better still, use the dipping tube, and keep the tank clear of all disjecta. The *Anthea cereus* ought always to be preserved in a vessel by itself, in order that it may have special attention. It is more impatient of heat than any of its tribe, and during summer the vessel containing it should be placed in a cool draughty place. It should have plenty of water, but not of any great depth, hence a large shallow vessel will be most fit for it. The stinging power of the tentacles should not be tempted by curious fingers, as the touch of the hand seriously injures it.

Among the annelides there are a few which should be kept apart from general collections, and *Aphrodite aculeata*, the sea-mouse, is one that requires special mention. The best place for this is a glass milk-dish or shallow vase, with at least two inches of fine sea-sand at the bottom. If you have several specimens, keep no more

than two in the same vessel; if each has a vessel to itself the better. Star-fishes are not altogether difficult to preserve; but they must be kept apart from the general collection, for they are given to the practice of absorbing mollusks out of their shells.

There are still many of the most beautiful and interesting creatures that may be associated together in the same tank, and those which will create the most interest, and endure the accidents of artificial treatment most patiently, are the popular species of *Actiniæ*. The first step should be made with the common *A. mesembryanthemum*, *Sagartia anguicoma*, (*Viduata*,) *S. troglodytes*, *S. bellis*, *Balanophyllea regia*, and *Corynactis Allmanni*. These are very hardy, and will afford experiences to guide the aquarian in the management of the more difficult kinds. But hardiest of the hardy is the first-named, and as there are several varieties differently coloured, a selection of half a dozen in a vessel of three or four gallons, with a few tufts of *Enteromorpha* may be considered the best and safest study for a beginner.

In the richest collection this common "Mes" is as valuable as the rarest, on account of its intrinsic beauty, and as to hardness and longevity, no creature of the deep, ever yet brought within domesticating influences, can equal it. When all goes wrong, and the pretty creatures drop from their stony pinnacles and perish;—when the water gets putrid, and, perhaps, half a dozen degrees of specific gravity too dense—"Mes" will still be found alive and unhurt, and will display its coral fingers and bright blue beads the moment he is lifted into a purer element. This is known by many popular names, of which the most common is "Strawberry Anemone." But it has so many varieties, that for mere effect this species is, in itself, sufficient for a small tank. In its most common form it is spotted on a crimson

ground, strawberry fashion; in another it is of a deep maroon, without spots. There is another variety of a deep quiet chestnut; another of a dark olive green, and a rarer and exquisitely beautiful one of a very bright,



Edwardsia vestita, Esop prawn, Enteromorpha compressa, Ulva latissima.

almost grass-green. I have sometimes managed to get one or two specimens of each of these varieties together at the same time, and by a little manœuvring to have them all expanded, side by side, and their distinctness and variety had a most charming effect.

When by the observation of the habits of those above enumerated, the beginner has attained to some experience, the following may be tried :—*Corynactis viridis*, *Sagartia aurora*, *pallida*, *rosea*, *venusta*, and *sphyrodeta*, (*S. candida*,) *Dianthus* (now named *Actinoloba dianthus*,) *Bunodes gemmacea*, and *clavata*, *Cyathina Smithii*, (*Caryophyllea Smithii*,) and the peculiarly interesting *Cerianthus membranaceous*, (*Edwardsia vestita*.) These may be considered as next in degree of hardiness to those first enumerated, and it should be the endeavour of the student to succeed in controlling the agencies of light, aeration, feeding, and the growth of vegetation before proceeding one step farther. If he cannot preserve these he must not venture to tame the *Anthea cereus*, or the rare *Adamsia palliata*, or even the comparatively hardy *Tealia crassicornis*, which few can manage, but which, nevertheless, may be so managed as to live, and thrive, and breed in the tank.

Among the *Annelidæ* are some that thrive under almost any circumstances ; the common *Serpula contortuplicata* and *Sabella tubularia* are long-lived interesting creatures, which hold on when all else goes wrong, and sometimes survive the wreck of a collection. *Serpula triquetra* is perhaps the most hardy of the family. The crustaceans also offer a few for beginners, of which the common prawn, the sandhopper, the hermit crab, and the common shore crab, *Carcinas mœnas*, are the best. *Cancer pagurus*, the common edible crab, is a hardy species, but only the smallest specimens should be taken in hand, and they should have plenty of room in a vessel with others of their own class. The *Tunicatæ*, or soft-bodied mollusks, are all difficult, but the common *Ascidia virginea* may be attempted without much risk. The true mollusks are all of precarious existence in the tank, and need the care of an adept. This remark applies even

to the pecten, the perforate oyster, and the species of periwinkle, none of which will live more than a few weeks, unless all the conditions are eminently favourable. Mr. Lloyd enumerates them as among the hardiest. I never knew of them being preserved for any length of time, except by the most experienced hands: with his run of water they doubtless do well, but I must caution the beginner, whose interests I am chiefly considering here, not to speculate largely on any of the shell-fish.

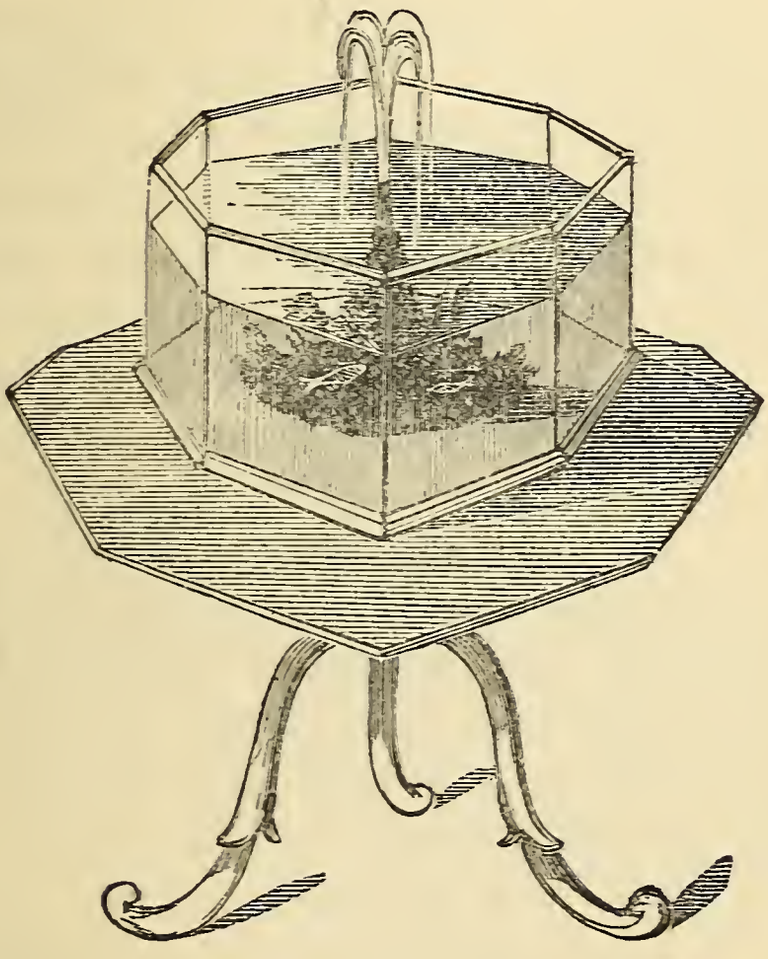
Bivalves are more troublesome than univalves; the common *Trochus* even is but short-lived, and when any of this class give up the ghost, they give up also a most obnoxious effluvia in their rapid decay, which is always accompanied with a large production of sulphuretted hydrogen, which blackens the rock-work, and makes the water poisonous to the rest of the creatures. Another evil of keeping mollusks in a tank with *Actinia*, is the tendency of *Eolids* to nibble holes in the jackets of the *Actiniæ;* this objection does not apply to the pretty *Doris*, which may be kept with other stock on terms of peace and amity.

Of course there will be a desire to add a few true fishes to the population of the tank; here is the highest reach of art in the management of the Marine Aquarium; the gobies and the blennies are the hardiest of the family, and may be preserved for many months in roomy vessels not overstocked, and kept at a pretty equable temperature. At the first start, however, have nothing to do with them, and when you have so far accomplished the mastery of minor difficulties, as to wish to take the fishes in hand, prefer the smallest specimens, have but a few in a vessel well furnished with microscopic vegetation, and may success attend the enterprise. The spotted gunnel should perhaps be ranked next in hardiness to the gobies and blennies, after that there is little differ-

ence among the few that offer themselves, but there is no valid reason why at least twenty species should not be kept in tanks; the difficulty is to give them space enough, for they are large consumers of oxygen. Fishes should never be kept with other stock; during summer will be the time of greatest difficulty, and the more space they can have then the better, and the vessels must be kept cool. Two species of goby—*Ruthensparri* and *minutus*, and one species of blenny—*ocellaris*, comprise all that I can with confidence recommend to the attention of novices; the experienced and earnest student will prefer to take his own course, and find his highest pleasure in overcoming obstacles to accomplish what others deem impossible or eminently difficult. During a sojourn at the sea-side the case is different. The fishes may be kept a few days, and then be restored to their native element. Even *Wrasses*, *Scylliums*, and the curious *Cottus bubalis*, if you can get it, may be made to minister to your thirst for knowledge, and your admiration of the beautiful and the quaint among natural forms; but away from the sea piscatorial desires are delusive, have a few gobies and blennies, and give them a large tank to themselves, and with that remain content, unless you determine to incur the risk and labour of original experiment.

If a run of water is to be tolerated at all, the desire to keep a few true fishes will afford the best excuse for it. If it is desired to keep a marine collection in the highest state of perfection, as an ornamental object, let it be furnished with a fountain, for which force must be obtained by fitting at a suitable height above the tank a reservoir of sea-water, and below the tank another reservoir for the waste. By means of a pump the water can be raised from the lower to the upper reservoir every morning, and the fountain set to work during

such hours as it is desired to enjoy its splashy music and sparkling appearance. The transit of the water from reservoir to tank, and from tank to reservoir, will keep it so thoroughly oxygenated, that a large number of fishes and zoophytes may be kept together to form a resplendent collection. An entrance-hall is an admirable place for such an ornament, and the subjoined figure will afford an idea of the best form of vessel for the purpose. As



the fitting of a vessel of the kind must be done by those professionally accustomed to the work, there can be no occasion for me to remark upon the mechanism or adjutage, except to caution those who may adopt it that the tanks should be of slate, and the supply and waste pipes of gutta percha. The nozzle of the fountain should be of glass. The presence of metal anywhere in contact with the water will sooner or later bring about fatal consequences, as sea-water is eminently corrosive.

Now leaving these brief suggestions of my own experience, let me give one example from many which I could adduce of successful results attained through following the instructions given in the first edition of this work. The writer says, "I have had an Aquarium in use for fifteen months, and as a proof of success I have kept *Anthea cereus* for eight months, and *Actinia crassicornis* for ten months. My *Rhodosperms* grow well. In tank and vases I have the following :—

Algæ.—Confervæ various, Cladophora rupestris, Enteromorpha compressa, Ulva latissima, Griffithsia setacea, Rhodymenia palmata, and Plocamium coccineum.

Zoophyta.—Four Actinia mesembryanthemum,* (fine striped, from Lundy,) seven A. gemmacea,* (two var. large, Isle of Man,) two A. clavata, (Weymouth,) two A. crassicornis,* seven A. bellis,* (three var. vulgaris, cornuta, and tynensis, of Tugwell,) six A. troglodytes, (five var.,) three A. dianthus,* (two var.,) one A. parasitica,* two A. rosea, two A. venusta,* and one A. nivea.

Madrepora.—One Balanophyllea regia.

Annelidæ.—Two groups Sabella reniformis,* one group Serpula contortuplicata, and one group S. triquetra.

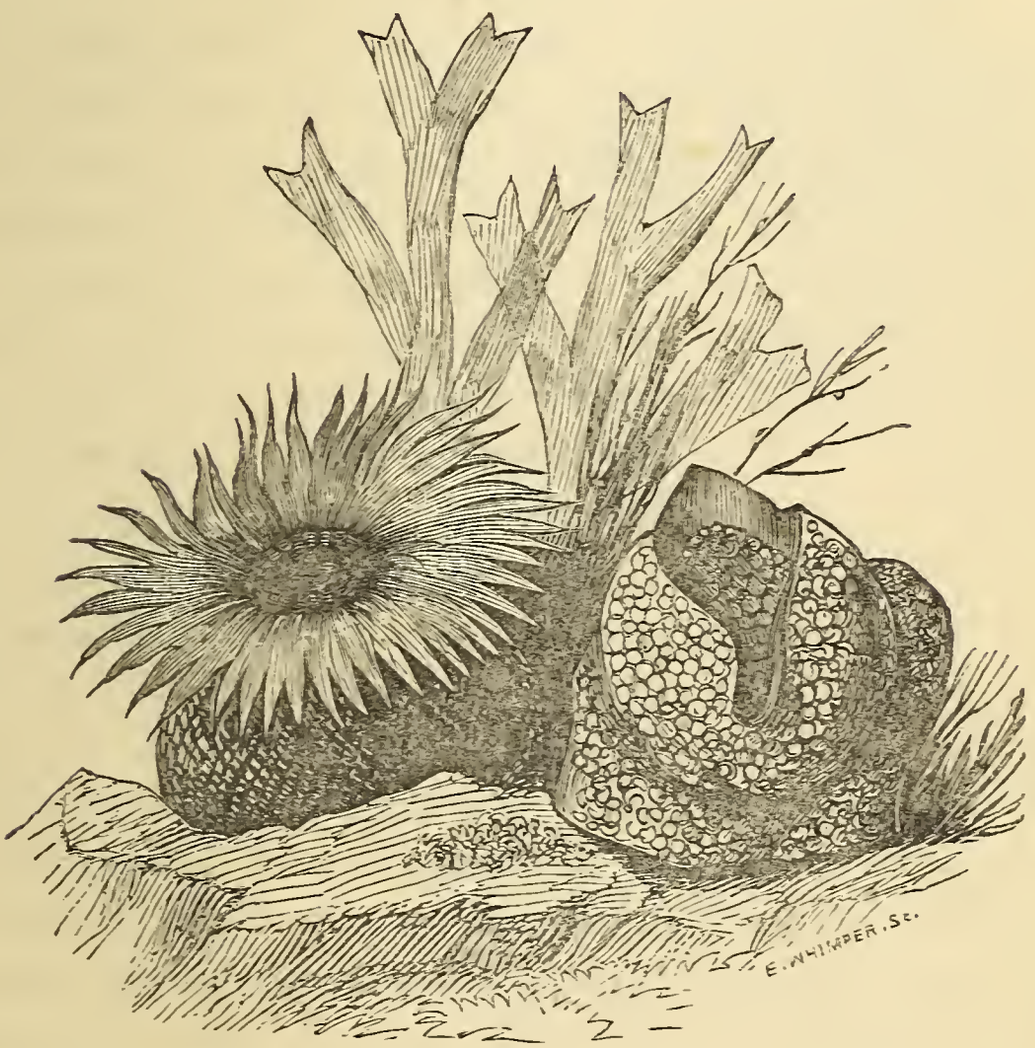
Crustacea.—One Pagurus Bernhardus, one Porcellana platycheles, and one Palæmon Leachii.

Mollusca.—One Eolis Drummondii."

One more example may be cited from the experience of Mr. Mummery, which was communicated to the British Association, in 1858, by Mr. Ward. Of the permanent inhabitants of this Aquarium were the following :—Actinia crassicornis, A. gemmaria, A. anguicoma, A. dianthus, A. miniata, A. bellis, A. nivea, A. mesembryanthemum, Sertularia planula, Bowerbankia densa, Pedicellina belgica, Tubularia indivisa, (in various states,) Aphrodite aculeata,

* Have produced young.

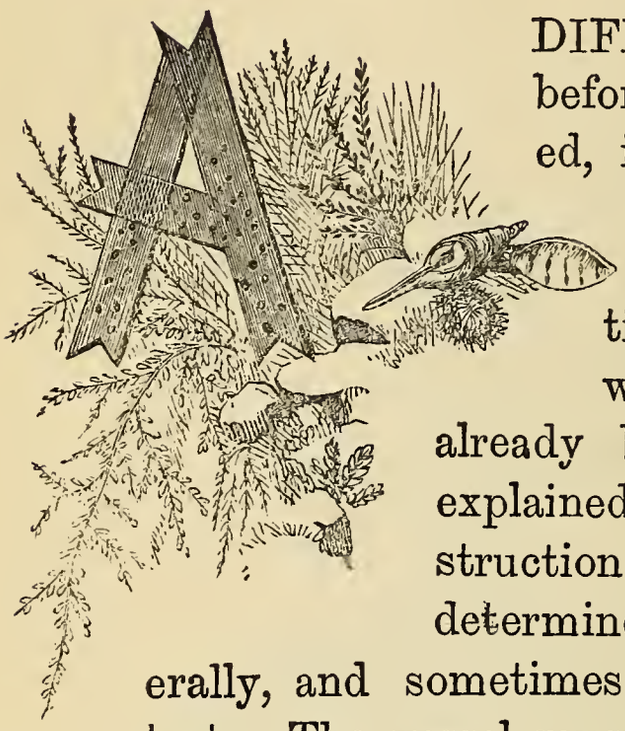
Serpula contortuplicata, Pagurus Bernhardi, Portunus puber, Balanus balanoides, Buccinum undatam, Patella, Œolis lineata, Palæmon. The three following could only be kept for a very few days :—Lepas anatifer, Cydippe pileus, and Lucernaria auricula.



ACTINIA MESEMBRYANTHEMUM. DYCTYOTA DYCHOTOMA.

CHAPTER VI.

THE BALANCE OF FORCES. MANAGEMENT OF MARINE COLLECTIONS.



DIFFICULTY to be overcome before any success can be assured, is that of furnishing the animals with plenty of oxygen, and at the same time keeping the vegetation within proper bounds. It has already been (sufficiently, I trust) explained, that the form and construction of a tank are not to be determined solely by what is generally, and sometimes erroneously, denominated taste. The vessel must be fashioned expressly for the purpose, else it will receive too much or too little light, get too quickly heated, or otherwise prove a grave instead of a preservatory. The first principle of success is to establish a due balance between the supply of oxygen by plants and its consumption by animals; for a deficiency of the life-sustaining element will be followed most certainly by the death of the most susceptible among the creatures. It is unfortunately true that very few of the so-called "sea-weeds" thrive in the Aquarium, but it is also fortunately true that we do not need them, except for the beauty of their form and colours, and as objects of botanical study, in which respect they are in the highest sense worthy of a place. The natural system of management I have endeavoured to describe in

the first section of this work *may* be set aside in the case of a fresh-water tank, but it cannot be set aside in the management of the marine.

Carefully inspect a marine vessel which has been in good keeping for several months together, and which, as far as practicable, has been "left alone." You will at first ask "how do the animals subsist without vegetation?" The tufts of *Ulva* and *Enteromorpha* have perhaps decayed long ago, many a *Rhodosperm*, and many a rare banner of green and brown put in at first, has been removed, simply because it began to decay there; and at first sight the vessel is destitute of plants altogether. Examine the blocks of mica and the fragments of old shells, and you will see that they are coated with brown, olive, and green patches, and with the help of a lens, it is no hard task to discover that the vessel is clothed over the whole of its submerged surface with microscopic plants, and there is a good botanical collection of *Vaucheria*, *Conferva*, *Oscillatoria*, and others of the same low order, all of which are profuse and constant makers of oxygen. Remove that tank so that a very little indirect daylight will find its way through the water, and in the course of a fortnight the vegetation will have increased in vigour, and the animals will show a corresponding langour, the *Actiniæ* closed up, the *Doris* immoveable, the *Annelids* sprawling on the pebbles—dead. Now turn it so that a full blaze of sunshine plays upon it many hours every day; it revives, comes to a right state of healthiness, and *then* the vigour of the vegetation passes a reasonable boundary, and just as the water is becoming turbid with *Zoospores*, and the rank growth of confervoids into twisted ropes, the animals begin to show evidences of a process of cooking, and those that are not visited by death seek death for themselves, and commit suicide by

turning themselves inside out. You must establish a balance, and maintain it.

The first step is to stock but moderately, and the next to regulate the amount of light so that you have enough and *no more*. How is this desirable growth of microscopic vegetation to be obtained? Simply by having patience. With real sea-water and proper rock-work it will come in abundance with time; but it is better to hasten the process by introducing a homeopathic quantity, allowing that to spread at its own will. Mr. Lloyd has hit upon an ingenious process of supplying any sized tank with enough to begin with, which he sends by post for a shilling. You are perhaps surprised at receiving a little phial containing clear sea-water, with only a speck or two of greenness in it. That is all you want. It is a portion of filamentous algæ possessed of vast powers of reproduction, and it will, on being put in the tank, soon take hold of every suitable scrap of rock-work, and prove a lasting and unfailing source of oxygen, and a better source than any of the more highly-organised plants common to the sea. In shore-gathering, when it is intended to form an Aquarium, save a few of the roughest-looking pieces of stone, tile, or earthenware that may come with the tufts of algæ in which you hunt for *Rissoæ*. Give the preference to those which have brown or green spots, and you have all you want—a seed-plot wherewith to render the tank fruitful.

The spontaneous growth of microscopic vegetation affords a good test of the relative degree of skill possessed by the Aquarium. If the rock-work is of the right sort, the shingle clean, and the vessel altogether free of cement, it is sure to appear in the course of a few weeks after first filling the vessel, provided the daylight is freely admitted from above only, but without

excess of sunshine. If the aspect must be south, let the window be furnished with blinds outside and inside, so that during bright summer weather a double screen may be used. In a north aspect a blind inside will be sufficient, and only at early morning, or late in the evening, during a week or two in June or July, will it be necessary to use it. Because an excess of light, especially if lateral as well as vertical, does so much mischief, the opposite extreme must be guarded against, of placing the vessel in a dark corner, where it is impossible for healthy vegetation to exist.

It does not follow, however, that because the microscopic vegetation is the most lasting, and the most easily preserved and increased, that therefore the higher forms which the marine flora offers are to be utterly abjured. Those useful plants, the *Ulvas* and *Enteromorphas* should certainly have a place, especially at first, as they make oxygen while the *Confervæ* are spreading on every nidus they can find. The sea-lettuce, *Ulva lactuca*, and its congener, *U. latissima*, are excellent Aquarium plants. *Enteromorpha compressa* and *intestinalis*, and *Cladophora rupestris* are of a similar degree of hardiness, and in uninterrupted but modified daylight subsist for many months, and sometimes, when the conditions are eminently favourable, spread from their native blocks to others adjoining, and make a rich carpeting of verdure, which greatly enhances the beauty of the collection.

The *Rhodosperms* or red sea-weeds have been proscribed hitherto as incapable of domestication. The improvements in the Aquarium place them definitely within our reach, and thus again the field of our labours and the circle of our pleasures are enlarged together. Too much light was the cause of the rapid decay of the *Rhodosperms*. The slope-back tank has rendered it not only possible but easy to preserve many of them, and thus in sus-

taining the balance the available means are increased, for these are certain producers of oxygen when preserved in health and vigour. The uncertainty incident to all the early attempts at the preservation of the *Rhodosperms* was not, however, wholly due to the mistakes which prevailed as to the proper forms of tanks. The collectors were in the wrong: they sent into the market good-looking specimens improperly collected, and they have had to learn how to collect, while we at home had been learning how to keep them. Success has attended the endeavour in both cases, and in tanks properly managed as to light, some twenty or more of the prettiest *Rhodosperms* may be adopted for permanent planting, while many others remain in that doubtful region on which a few bold spirits will enter in a determined conquest of difficulties.

The algologist will do better, however, to assort his marine plants in cabinet jars, instead of entrusting rare species to the risk of decay in a tank. Get together a lot of small jars of flint glass, such as I have described as necessary for the formation of a fresh-water cabinet. Put an inch of sea-side grit, quite free of chalk or mud, into each, and fill with sea-water dipped at some distance from the shore, and drop in a few small tufts of *Ulva* and *Enteromorpha*, on clean limpet shells, if they can be got, or any hard rock not likely to decompose in the vessels. Place these in a window, and wait till the sides next the light are coated with a regular green film of vegetation, and then introduce the red algæ, which will thrive behind the screen of vegetation thus prepared for them. I have kept several of the *Callithamnion*, the pretty *Griffithsia setacea*, *Irideæ edulis*, *Chondrus crispus*, *Melobesia membranacea*, and the pretty *Jania rubens*, with others of similar constitution, by this method, and by a similar one of covering

one half of a large bell-glass with pale green tissue paper, by means of copal varnish,—a plan to be recommended in the preparation of all cylindrical vessels used for marine purposes, if the aquarian cannot well wait until a natural screen of algæ is formed on the inner sides. The fronts of such vessels must, of course, be kept clean by means of the sponge and stick, or a piece of wood cut to a wedge-shape, and covered with wash-leather or sponge. The sign of ill-health in a *Rhodosperm* is the breaking out of orange-coloured spots. If such a sign be visible on any specimen remove it at once, and consider once more whether there is too much or too little light. In winter the last-named condition will probably be the cause. Move the vessel nearer to the window; an improvement in the stock will probably be the result.

It is thus apparent that the recommendation of mollusks to cleanse away conferva was an error now happily exploded. Instead of feeling the necessity for tops and winkles (which never did their work satisfactorily) they now take their place with other live stock, to be kept or not, as the aquarian pleases. As they are interesting objects of study a few will be useful, but we no longer labour under the delusion that we must have plenty, to the exclusion perhaps of many creatures that would add to the variety of the collection. Let the conferva grow where it will, provided the view of the contents remains open. The more of it the better, and without it the microscope has its range of usefulness limited, for it is among these minute growths the student will find the most interesting subjects of observation. The reduction of the number of mollusks increases the value of life to all the rest of the inmates.

GREEN STAIN.

Let us consider for a moment what is to be done when the spontaneous vegetation gets the upper hand. A sudden burst of hot weather will sometimes be followed by a turbid state of the water, which, when submitted to the microscope, will be found to be dense with suspended spores. Excess of light will bring about the same state of things, but hot sunshine is in general the most actively disposing cause. In the first edition of this work I recommended filtering as a safe and certain remedy. It had so proved with me on several occasions, and I again recommend the passing of the whole of the water through a filter, even if for a short time the tank is left empty, as the best remedy with all the old-fashioned tanks and bell-glasses. Draw off the whole of the water into an earthen pan or other non-metallic vessel; the *Actinia* will take no harm, and perhaps be benefitted if left uncovered for an hour. There will be quiet enough moisture among the pebbles and shingle to prevent disasters, except with fishes, which should be caught and transferred with the water. Suspend over the tank a glass funnel with a bit of sponge inserted in the orifice, just tight enough to prevent the water from flowing through in a stream. It should merely drip through. Suspend this over the tank and fill it, and continue to re-fill till the whole of the water has been returned. If the case is a very bad one return only enough to give a depth of three inches, cover the remainder with a board, or whatever else may be handy, to exclude the light, and filter that portion into the tank next day. The water will be bright once more, and, to prevent a repetition of the annoyance,

reduce, while the hot bright weather lasts, the amount of light.

It is on such emergencies as these that we discover the value of a properly-constructed tank, in which, by the way, accidents of the kind are of rare occurrence, and ought not to happen at all. A few minutes labour with a small pump suffices to change the water from the light side to the dark, and from the dark to the light, and there is an end of the difficulty. In the "water chamber" the green stain is soon destroyed, and the water rendered fit for another change in the course of a few days should it become necessary.

CHANGING THE WATER.

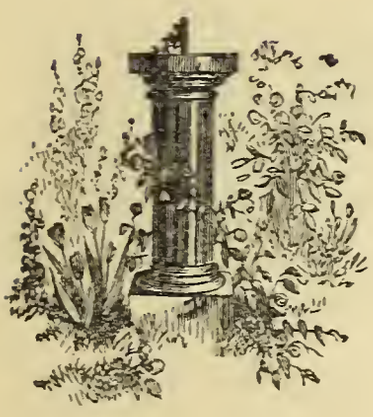
These remarks on changing the water may in the absence of a word of explanation lead some readers into the error of supposing that periodical changes of the water are essential in the management of a Marine Aquarium. It must be understood then that to all intents and purposes the same water may be used continuously in an Aquarium for an indefinite length of time, no matter whether the collection be fluviatile or marine. To periodically change the water is to violate one of the first and essential conditions under which the Aquarium consists, and destroy half its interest as an object of scientific observation and experiment. The only changes of the water admissible in the scheme of management are those necessitated by peculiar circumstances, and in essence they are essentially exceptional. In a private dwelling it is just impossible to establish a run of sea-water through five or six hundred cubical feet of tank space, with the help of thousands of gallons of sea-water, as Mr. Lloyd does in the prosecution of his trade as a dealer. And were it possible it would not

be advisable, for we do not want to *warehouse* the zoophytes in fifties and hundreds, but to keep a few as domestic pets and examples of the Infinite Wisdom which has so strangely fitted them for their submerged existence. To do this with a supply of water once for all is a triumph of practical science, and one which must be the aim of every aquarian who would derive from his pursuit some higher pleasures than the momentary gratification of mere curiosity. Of course, practically the same water does not last long; there must be added from time to time supplies of fresh water to make good what is lost by evaporation; nevertheless it is the same water in a certain sense, in the enforcement of which not another word need be wasted.

CHAPTER VII.

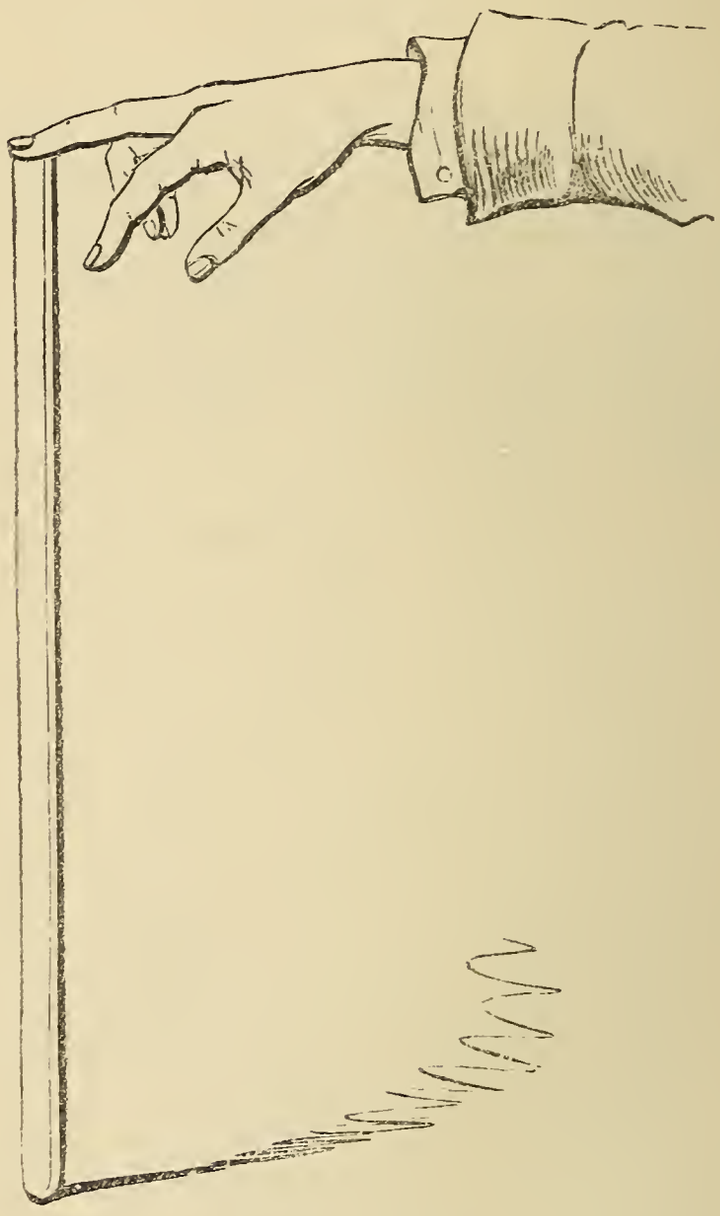
A CODE OF MANAGEMENT FOR THE MARINE AQUARIUM.

STOCKING.



IN stocking the tank bear in mind the necessity of a proper method of grouping, and proportion the number of animals to the bulk of water and the extent of surface exposed to the atmosphere. Wait till there is a pretty good growth of minute algæ before introducing the full compliment of animals, and the best sign of fitness for their reception is the appearance during mid-day of multitudes of small globules on the surfaces of the rock-work. Give the preference, when purchasing stock, to the specimens which are attached to pieces of rock, shell, etc., these having never been removed from their selected places, are sound at the base, and likely to live longer than those that have been separated. This remark applies especially to *Bellis*, *A. anguicorna*, *Anthea cereus*, *crassicornis*, *gemmacea*, and *corynactis;* but very many of the hardier kinds are easily removed without injury, and if obtained from skilful collectors will be none the worse for the separation. On receiving collections by railway or through the post unpack them at once; throw all the waste algæ in which they are packed into a shallow dish, with a little sea-water, and at the first opportunity search it over with a lens, as it often contains objects of interest not bargained for, but as it is *waste* in the strictest sense of the term, it is not to be

placed in the Aquarium. Into another shallow dish place the animals one by one with care, and if possible lift them out from among the weed by means of a large spoon, in preference to touching them with the hands. Anemones generally expand immediately after being



DIPPING-TUBE.

unpacked and placed in sea-water, but as it is not desirable they should fix themselves in the vessel they are not to occupy permanently, place them *face downwards*. In the course of a few hours they may be transferred to the tank, as nearly as possible in the positions where it is wished they should remain. Some will attach at

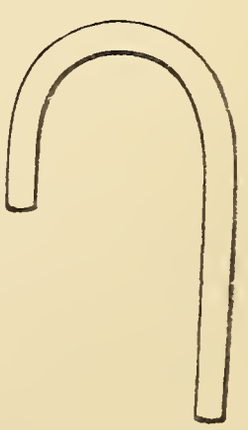
once, others will roam about to find sites, and it will be a folly to interfere with their choice, even though it may lead them into positions not favourable for their inspection.

PRESERVATION OF THE WATER.

To keep all bright and pure have a dipping-tube, a syphon, and a sponge attached to a stick, always at hand. When the actinia or mollusks change their jackets remove the disjecta by means of the dipping-tube. Decaying algæ must also be removed as soon as the fronds loosen away from their foot-hold. The dipping-tube is a glass tube of a quarter or half an inch diameter, open at both ends. Place a thumb or finger on the top of the tube, and thrust it down over the object to be removed, then remove the finger and the matter will rise in it. Lift the tube up to the surface of the water, then place the finger on again, and lift the whole away. The advantage of this plan is, that no disturbance is occasioned. A pewter spoon bent to a right angle, and attached to a stick, is very useful for lifting up objects that are too large for the dipping-tube.

AERATING.

The syphon is a simple affair enough. In using it, place the short end below the surface of the water in the tank, and apply the mouth to the longer end, and draw till the water flows; it will then continue to flow as long as the short end is kept under water. If you object to promote aquarian science by means of suction, first fill the syphon with water, and apply a finger to each end, and so turn it over, and withdraw the



fingers when the short end is dipped beneath the surface of the water in the tank. Syphons are manufactured expressly for the purpose, one of which the aquarian should possess.

Some plan of artificially aerating the water must be adopted with every newly-established Aquarium. Until the plants have established themselves there will be a deficiency of oxygen, which must be supplied by agitating the water at the surface. If the tank is stocked before the plants are well established, or if overstocked with a crowd of animal life, or if sulphuretted hydrogen be produced and make its presence manifest to the nose, *then* aeration must be resorted to. A cup or jug may be used to dip the water from the surface, and pour it back again from a height in a thin stream; or a filter may be placed over the tank, and filled from the surface, and the water allowed to drip back; but the most efficient instrument is a common syringe. This is simply to be charged at the surface, and discharged again with some force, so as to send a stream of oxygenized water deep into the tank. The process should be repeated for a quarter of an hour at least.

Another very simple mode of aerating is to take a piece of whalebone, or a porcupine quill, dip it into the water a reasonable depth, and move it backwards and forwards quickly. This causes the entanglement of air at the surface, which serves to oxygenate the water and destroy impurities.

A plan adopted at the Zoological Gardens at Dublin is found very effectual. It consists of a tube, at the end of which is a pair of bellows; from the tube branch pipes pass into each Aquarium, so that every stroke of the bellows sends a quantity of fresh air into each tank. The amusement of pumping the air into the tanks is so great, that they had never had in the Dublin

Zoological Gardens occasion to employ a man to do it, as the visitors were very fond of the occupation. On one occasion a cuttlefish had died, which they had kept for three months, and on examining into the cause it was found that the bellows were broken.

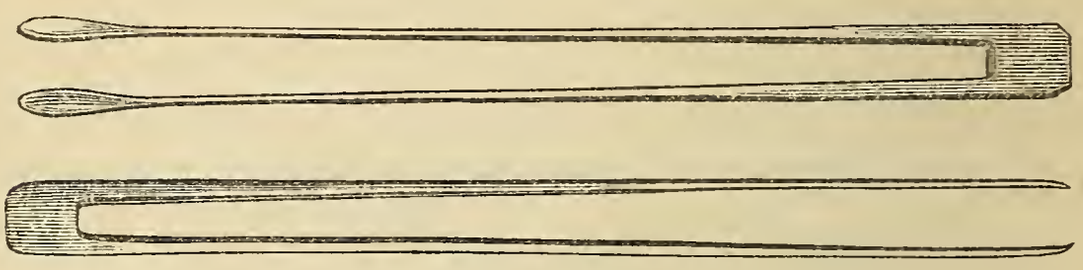
DENSITY OF THE WATER.

Evaporation causes the pure water to escape from the Aquarium, and hence there is a constant tendency to increase of density; in fact, if left alone, the water in the tank soon gets too salt. To prevent this, additions of pure spring or distilled water must be made from time to time, and the amount regulated by a specific gravity bubble, which it would be as well to leave at all times floating in the tank. This instrument registers the density much more accurately than the hydrometer, for it is more delicate in its determination of a balance. I find it expedient to use two bubbles of different specific gravities—one which just floats when the water is sufficiently fluid, and another which just sinks when it is sufficiently saline. The movement of either indicates at once the exact cause, and enables the aquarian to regulate the density to perfection. In hot weather evaporation takes place rapidly, and the position of the bubbles should be noted every day.

FEEDING.

Every kind of marine stock requires regular feeding. It is true that in a thriving tank microscopic life is so abundant, that to a certain extent the collection is self-supporting, and many *Actiniæ* thrive for years together without artificial nourishment. Nevertheless, feeding makes them plump, increases their beauty, and promotes

breeding. The best food is minced oyster. It should be cut up as small as mustard seed for the lesser inhabitants, and not larger than peas for the most voracious. Have the minced oyster on a clean slab of marble or wood. Take a piece by means of a pair of wooden forceps, and lower it gently into the mouth of the



FEEDING FORCEPS.

creature. *Crassicornis* and *Dianthus* may have two or three such pieces, the small actiniæ one piece for a meal. The minute zoophytes and madrepores will be well fed if a little of the white, semi-fluid, gelatinous, creamy matter which remains on the slab is dropped in above them, so as to sink in a cloud. This process should be repeated twice a week. A few hours after feeding remove with the dipping-tube all refuse, or there will be a production of sulphuretted hydrogen.

PERIODICAL CLEANSING.

A well-managed Aquarium will continue in a good condition for an indefinite period, but until the conditions of success as to the amount of light, the proportion of stock, and so forth, are attained, a few accidents may happen. The invariable consequence of neglect is a production of sulphuretted hydrogen, which is always evolved during the decay of animals which have perished, and particularly during the decay of mollusks. If you miss for some time any particular specimen, search for him at once ; if merely hiding in a dark nook leave him

to enjoy his solitude: the necessity for the search is that he may have crept into a corner to die, in which case it must be immediately removed. If all goes wrong, and death unfurls his black banner, and makes a sepulchre of your so-called vivary, the vessel must be emptied by means of the syringe, and the whole of the furniture removed and cleansed. The water need not be thrown away unless it is convenient to obtain a fresh supply, which will save the trouble of restoring the tainted water to purity. The restoration is to be effected by placing it in an earthen glazed pan, or similar clean vessel, throwing into it a handful of charcoal, and placing it in the open air for a week, by which time it will be as bright and pure as at first, and thoroughly oxygenated. If a few animals remain alive place them in a shallow vessel, and prepare sufficient of the water to cover them, by pouring it from one vessel to another for a quarter of an hour, before immersing the creatures in it. The water which is exposed to the air to be purified should be covered during rain, or its density will be too much lowered. Sunshine will hasten the restoration. Pass it through a filter before returning it to the tank.

CLEANSING AND RE-FITTING.

In making ablutions and purifications, any green deposit on the rock-work must not be disturbed, nor must any spawn be removed from the sides of the vessel; these are to be welcomed as the germs of new plants and animals, which, with proper attention, will soon make their appearance, increasing your stock with healthy home-grown specimens. From the spores of green algæ with which the stones ought to be studded, an immense number of oxygen bubbles will be escaping; this is the life of the tank—all goes on well when this appears profusely,

and when the spores put on a downy or woolly appearance, you may consider your Aquarium as established. The larger algæ, if they increase, will require an occasional thinning; if they decay, they must be removed, and their place supplied by fresh ones. In winter-time the weeds will sometimes turn white, and if it is not convenient to renew them, they must be taken out, and the decayed portions trimmed off by means of a pair of scissors. The stones on which they grow should then be scrubbed with a brush, and rinsed in waste sea-water, and replaced.

In replacing the animals and plants on any occasion of emptying the tank, the stones should be looked over, to see if any are tainted with black spots. The inky patches sometimes observed on stone, sand, and shells, are the result of animal decomposition, and the consequent evolution of sulphuretted hydrogen, a gas not only poisonous to animal life, but which, by a peculiar law in the chemistry of fluids, drives the oxygen out of the tank. By turning these blotches to the light, they will gradually disappear; but the quickest and most satisfactory way is to touch them with diluted sulphuric acid, taking care that the weeds are not touched at the same time. The stone must then be plunged for a few miuutes into a basin of waste sea-water, to remove the acid, and may then be replaced.

ALL'S WELL.

Some ten or twelve days after the complete stocking of the tank, you will be enabled to judge fairly if you have done the work well. I have sufficiently enumerated the signals of distress; the signals of prosperity are of another kind. If the carpeting of felt-like vegetation spreads in green, and brown, and crimson patches from stone to stone; if the old shells get tufted with algæ,

and a beading of bubbles appears profusely on all the submerged surfaces; if the *Actiniæ* change their forms, expand their tentacles, eat when food is given them, and shew no tendency either to drop from their moorings, or shrink into button covers; if the *Holothuria* curl and twist themselves, and keep their fringed heads upright, and show no tendency to turn themselves inside out; if the star-fishes keep all the rays that belong to them, and send none adrift to lead for a short while a dismembered life; if the prawns go about like ghosts, and the crustaceans explore every cranny of their allotted space in their own department; you may look up your hand-lenses, get the compound microscope ready, secure Gosse's "Actinologia Britannica," Bell's Stalk-eyed Crustaceans, Johnston's Lithophytes, Harvey's sea-side book, the Nature-printed Sea-weeds, and "Recreative Science," and sit down to a quiet exploration, comforted by an inward assurance that "all's well."

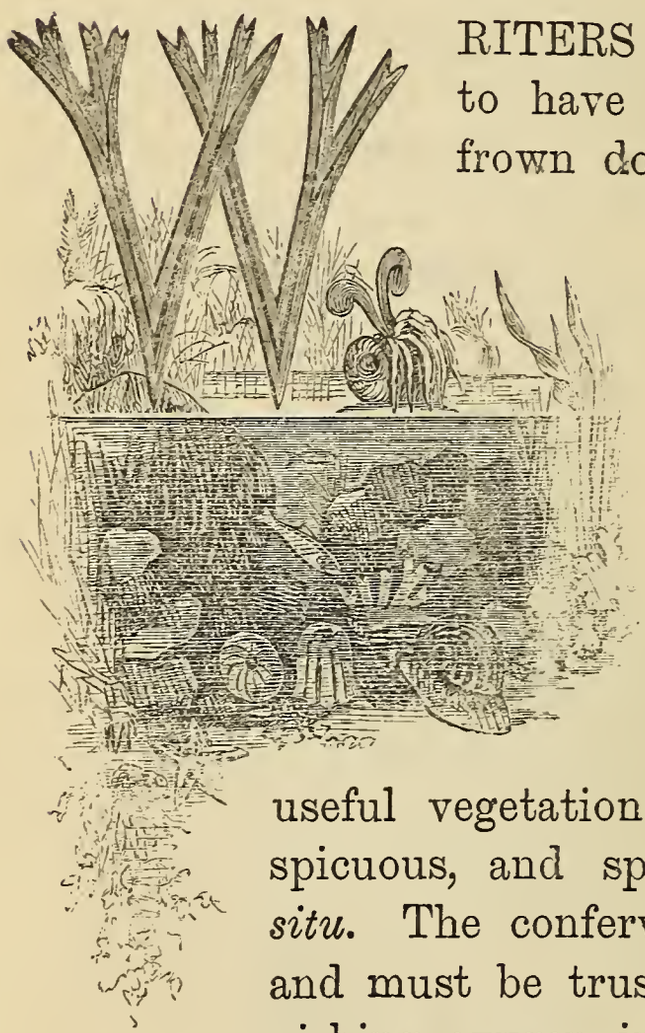


Actinia mesembryanthemum, Cribella oculata, Palmipes membranaceous, Padina pavonia, Cladophora arcta, Polysiphoniæ urceolata, Ulva latissima.

CHAPTER VIII.

"——— "SEAS have
As well as earth, vines, roses, nettles, melons,
Mushrooms, pinks, gilliflowers, and many millions
Of other plants, more rare, more strange than these."
DU BARTAS.

BOTANY OF THE MARINE TANK.



RITERS on the Aquarium seem to have united in a compact to frown down botanical studies. It is quite true that the animals take precedence in the tank, and that the plants are chiefly used in order to effect that necessary balance on which success depends. It is true also and a matter of highest importance, that the most useful vegetation is that which is inconspicuous, and spontaneously produced in *situ*. The confervoids are our best friends and must be trusted with the task of furnishing oxygen in all attempts at the culture of plants of a more noble growth. Still I can see no reason why we should not make the best of our water-gardens, for the culture of curious and beautiful plants. We must always depend on *Enteromorpha* and *Ulva* for the preparation of artificial sea-water; and when

the vessel has been some time stocked, a very moderate share of skill would enable any one to incorporate with its contents some of the more elegant forms of Algæ, of which there is certainly a large choice from species noted for their beautiful outlines and gay colours. If ferns convey the idea of perfect grace in the forms of terrestrial vegetation, the perfection of colour is certainly attained by the *Rhodosperms*, which display tints unrivalled by few kinds of terrestrial foliage; and in their growth and structure reveal many curious examples of adaptiveness to the peculiar circumstances under which they are produced.

The majority of Marine Algæ flourish near the shore; the deep sea does not appear to be productive of any great variety of vegetation. This might be expected, seeing that vegetable colours are only produced under the action of light; though in tropical climates, where the intenser light will penetrate to greater depths, and a high temperature will promote whatever growths there may be light enough to support, there will be exceptions to the case in temperate latitudes.

The *Mer de Sargosse*, or Weedy Sea—now well known as to its limits and character—was a region of mystery to the old Spanish aud Portuguese mariners, and its passage by Columbus forms a charming episode in Horace St. John's picturesque life of the great navigator. But Columbus was not

> ——"The first that ever burst
> Into that silent sea;"

for the Phœnicians—the fathers of marine commerce—reached it in thirty days sail from the Mediterranean, and gave it its historical name—the Weedy Sea. There are, in fact, two such seas in the Atlantic; one lies between 25° and 36° of latitude, a little west of the meridian of Fayal; the other occupies a space between 22° and

26° in the 70th degree of longitude, about two hundred and seventy miles east of the Bahamas. Each of these regions bears the character of a vast marine meadow, "sweeping in huge floating fields far as the eye can reach." But what is most interesting in the history of this phenomenon is the immense size of the *Fucoids* which form the floating masses, and the immense depths at which they are produced. Lamoroux observed stems upwards of eight hundred feet long, not fixed to the bottom, but floating freely on the surface of the water; fronds of from two or three hundred feet are common. At the immense depth at which these are produced it is believed that all is calm, and still, and unruffled—a motionless silence, and a green twilight; and hence it seems at first sight difficult to explain in what manner the huge forests get uprooted; but Lamoroux observed that though the *fuci* adhere to rocks with great firmness before the display of fructification, yet, as soon as this took place, the plants detached themselves and rose to the surface, either to ripen their spores under the action of light, or because their term of existence had expired.

The curious modes by which the germinating principle is developed in plants which require exposure to light at the period of fructification, are very strikingly exhibited in aquatic plants, as in the *Vallisneria spiralis*, which sends up a spiral stem to the surface; the *Stratiotes aloides*, which detaches itself from the bottom, and floats during the time of its blooming. Humboldt has seen a *fucus* vegetating at a depth of one hundred and ninety-two feet, where it could receive light equal only to half of that supplied by a candle at the distance of a foot, and which, notwithstanding, was as green and glossy as a meadow in spring.

A tribe of plants which are capable of interrupting the lines of navigation, which contribute in their living state

articles of food and luxury, and when dried medicines and ornaments, which furnish us with soda and iodine, and other valuable chemical agencies, not forgetting their importance as manures for the land, must surely be worthy of the attention of the student, who may now class them with his window flowers, and while noting their physical economies, derive delight from their distinctive forms and colourings, and picturesque outlines, enhanced by the transforming power of the medium through which we view them.

There with its waving blade of green
The sea-flag streams through the silent water,
And the crimson leaf of the dulse is seen
To flush, like a banner bathed in slaughter.
There, with a slight and easy motion,
The fan-coral sweeps through the clear deep sea,
And the yellow and scarlet tufts of ocean
Are bending like corn on the upland lea.
And life in rare and beautiful forms,
Is sporting amid those bowers of stone,
And is safe when the wrathful spirit of storms
Has made the top of the waves his own.

Percival.

ALGÆ.

When we speak of *Diatoms* or *Confervæ* as algæ the unlearned reader is immediately perplexed at the association with them of such highly-developed forms as *Rhodymenia*, *Griffithsia*, and others of the popular handsome sea-weeds. The association is physiological. All the algæ are cellular plants, and the mode of their increase furnishes the principle of their classification under one general head. An alga has neither leaf, stem, nor root, that is, according to the proper acceptation of those several terms. The plant itself is a thallus, simple or divided, bearing upon it the organs of fructification. In some cases increase is effected by means of *phytozoa*, or true plant-spores, contained in antheridian cells, the structure of which bears some

analogy to the organs of fructification in true phenogams. In others the increase is by *zoospores*, or pseudo-animal gemmules. Though they *may* be truly vegetable, yet as these zoospores possess moveable *cilia*, the action of which enables the spores to transport themselves from place to place, they indicate an approach towards the confines of the animal kingdom, if they do not actually come within it. As opinions are so divided on this point, let it suffice that some algæ propagate by spores which have the powers of locomotion, the immense production of which in the tank is sometimes the cause of a green turbidity, which is destroyed by darkness. The lowest tribes of the order are the filamentous algæ, in which reproduction is effected by the conjugation of the cells to produce a spore; others again, which are perhaps lower still in the scale, increase by spontaneous fissure, the cells themselves dividing, and each division acquiring during the process individual completeness. There are four divisions of algæ in the classification adopted by Lindley. They are 1.—*Fucaceæ*, the olive and brown sea-weeds. 2.—*Ceramiaceæ*, the rose-red, purple, and red-brown sea-weeds. 3.—*Confervaceæ*, one or many-celled plants, the cells containing a green endochrome. 4.—*Diatomaceæ*, the brittleworts, in which there is a unilocular or separate cell, and the reproduction is by self-division, conjugation, and the formation of sporangia. The study of these several sub-orders, and especially of their distinctive modes of reproduction, might well engage all the leisure hours of those who have taken the Aquarium in hand, as much for the love of science as for the means of recreation and home adornment. It cannot, however, be entertained in these pages, which are far too few, even for the enumeration of the several points of special interest. Let us then be content here with the more popular,

but less accurate division of the algæ into two great classes, the green weeds and the red weeds. The first of this is the

CHLOROSPERMEÆ.

Of these, as before stated, the microscopic forms are produced in abundance in the tank in the course of time, and until they are abundant no certain progress can be made in the preservation of animal life. Those which can be most readily introduced in a palpable form are the *Oscillatoria*, *Bangia*, *Conferva*, and *Vaucheria*, the two latter being eminently valuable as makers of oxygen. Others of the series that adapt themselves pretty readily to the confinement of the tank are *Porphyria*, *Ulva*, *Enteromorpha*, *Cladophora*, and *Bryopsis*. All these are easily procurable on any of our coasts at low water, and usually have concealed among their fronds numerous specimens of *Lucernariæ* and other small animals, which will afterwards display themselves in the tank, if speedily conveyed to it without exposure to the air. For this purpose, however, the *Zostera marina*, which is not an alga, but a naiad, and the plant used to cover Italian flasks, is the most useful, but it needs a large tank and much skill to keep it any length of time. *Ulva latissima*, (the sea lettuce,) is a most elegant and hardy plant, already sufficiently described; a tank is not complete without it; and the same may be said even more emphatically of that sheet anchor *Enteromorpha compressa*. *Codium tomentosum* is another green weed, which should be obtained if possible, as many of the mollusca will eat nothing else. It is not over elegant, but thrives well in confinement. When obtained fresh from the sea, it is sometimes studded with interesting mollusks. The *Cladophoræ* are plants of simple structure, consisting of jointed threads

grouped into bushes and tufts of various tints of fresh green. *C. uncialis* and *C. rupestris* are the prettiest; *C. arcta* is a strong dwarf kind, which forms little upright bushes rather stiff in outline; it is ragged and coarse in texture, but worthy of a place if there is room. They all thrive and increase with little care. The plants of the genus *Chondrus* are very beautiful, but apt to create turbidity; at least such is my own experience. *C. crispus* is certainly the best; it is very beautiful, putting out spreading fronds, which divide into elegant rounded segments, which "glow with refulgent reflections of azure, resembling the colour of tempered steel." The *Chondrus* in a dried form is the carrageen moss of commerce, everywhere domestically known for the valuable jelly which it produces. *C. Norvegicus* is a rare plant to be sought by collectors.

Punctaria latifolia is perhaps the most elegant of all the green weeds that may be readily domesticated. It resembles somewhat the well-known ladies' tresses, and sends up its fine waving fronds of pale sea-green, almost to the surface of the water, forming beautiful arches of pellucid tissue, through which the fishes glide and gambol, keeping it in constant motion to and fro; it lasts a long while, and if all goes well will increase rapidly. *Bryopsis* is another genus that furnishes a few good specimens. *B. plumosa* is a very elegant but small plant, which sets at defiance all ordinary adverse circumstances, and dots the stones with its spray-like tufts most luxuriantly. It delights in crevices, and should be dropped into the deepest part of the tank. *Dictyota* is a genera that does well; these have fragile pellucid fronds, flattened and freckled, branching into angular segments, and are so frail and tender that the slighest touch injures them severely. They are by no means showy, and are not necessary in a small collection.

RHODOSPERMEÆ.

The red and crimson plants afford a still greater variety; the loveliness of some being unequalled in the whole vegetable kingdom. That superb plant, the *Delesseria sanguinea*, takes the first place among the crimson weeds. The *D. alata* is another species of the same genus; and of the two it is difficult to decide which is the most lovely. The first has elegant leaf-like fronds of a delightful crimson, each frond springing from a stem, and being elegantly ribbed and wrinkled, after the fashion of the leaves of land plants. The second grows in thin much-cut leaves of a very rich crimson, and is called *alata* or winged, in consequence of its divided outline. There are several species, all of great beauty. *D. sinuosa* and *D. hypoglossum* are the best after the two just named. They all thrive in vessels which are not over illuminated, but lateral light destroys them quickly. The only way to increase their chance of life in a tank formed of glass all round, is to cover the plate next the window with green paper, or let it get well coated with confervæ.

Perhaps *Ptilota* should stand next in point of beauty. There are only two species—*P. plumosa* and *P. sericea*. They are both delicately formed, the fronds being cut into fine divisions, so as to resemble, perhaps rather remotely, some of our more delicate kinds of ferns. They are of a duller red than the *Delesseria*, but the elegance of their feathery out-

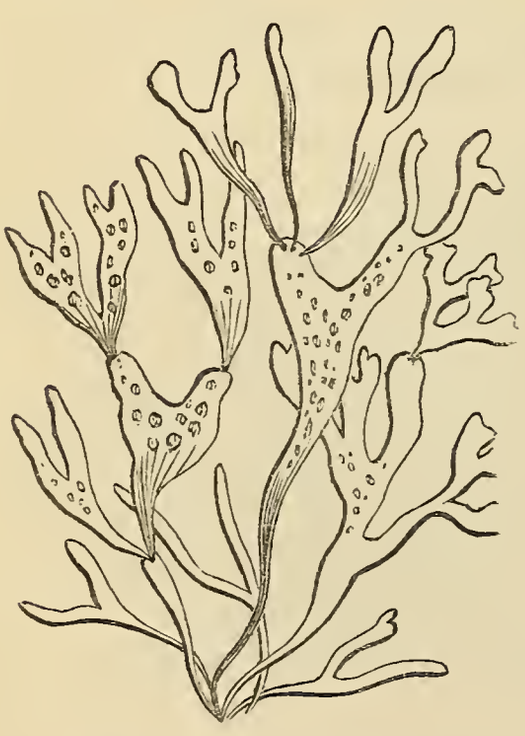


PTILOTA PLUMOSA.

lines has a charming effect. They may frequently be found on the clefts and ledges, covered with the fuci which the tide leaves uncovered on the coast.

Polysiphonia, *Dasya*, the minute *Calithamnion*, and *Ceramium* are all of similar jointed thread-like structure, and of a dull red or bluish-tinted crimson. They are easily obtained, and flourish in the tank, but are not conspicuous for extraordinary beauty. Different it is with that glorious Neried, the *Nitophyllum punctatum*, which shines amid the dark green waters, as if it were always pleased, while its growth is rapid and certain if the tank be well kept. There are six species of *Nitophyllum*, but this is the worthiest of a worthy tribe. The frond is broad, and spotted with dark crimson marks, which seem to shine through its delicate texture, as if they came through from behind; while the edges break into a number of segments and delicate puckerings, increasing and broadening from below upwards. *N. versicolor* is the next best; but the other members of the genus do not succeed so well as these two.

The two species of the genus *Phyllophora*, namely, *P. rubens* and *P. brodiæi*, are of great service, not only for the fingery form and bright crimson colour of their fronds, but for the immense amount of oxygen they throw off when once established, and which tends so much to the health of the animals in the tank. They are obtained, along with plants of *Delesseria*, from the rocky clefts at low-water mark; but the best specimens are those brought up by the



PHYLLOPHORA RUBENS.

dredge. I consider it indispensable for the reasons just described.

Rytiphlæa pinastroides is another handsome red species, which flourishes abundantly under the worst of circumstances. The same may be said of *Griffithsia*, named in honour of Mrs. Griffith, of Torquay, the most distinguished of British Algologists. This plant bears some resemblance to the small *Equisetaceæ* of the hedges—a number of thread-like and jointed growths springing from a centre. It might also be compared to a tuft of fine grass, such as *Briza gracilis*, for instance; except that instead of being of that fresh cheering green, it is of a most delicate rose-colour. Dr. Harvey, in his "Phycologia Britannica," speaks of the ease with which this plant may be domesticated; and experiments in Aquaria bear out his statement. No sea-weed thrives better than this; but there is a difficulty in obtaining it from its natural site on the low ledges, owing to the slight hold it has upon its place of growth. Its base is so minute that the collector is pretty sure to break away several specimens before he secures one firmly attached to the rock. If ever so slightly attached it lives and thrives; but if removed altogether it perishes.

Every one knows the *Plocamium*, which produces those crimson trees so much used by taxidermists in mounting stuffed birds in glass cases, and in the making of sea-weed landscapes. It is very brilliant in colour, and excessively ramified, but not to be strongly recommended in the formation of a marine garden. Another plant of the red kind which can be safely recommended, is the *Cystoseira ericoides*. It is not to be found in the immediate vicinity of the beach, but may be hooked up from a boat in about one fathom's depth of water, at low tide on a rocky bottom. It may then be seen forming bushes of large size, springing from the crevices

of the rock, but too far from the surface to be got at by hammer and chisel. If torn away with some vigour, some of the best portions of a shrub may be brought up, and these bound to the surface of shells or stones, make temporary ornaments of most gorgeous colouring for the Aquarium. When brought up it has a dull yellowish hue, but the moment it is submerged in its native element, all its glory returns, "the pale olive branches become invested with a most brilliant flush of iridescent light blue, not changeable in tint, though varying in intensity, according to the play of light that falls upon it."

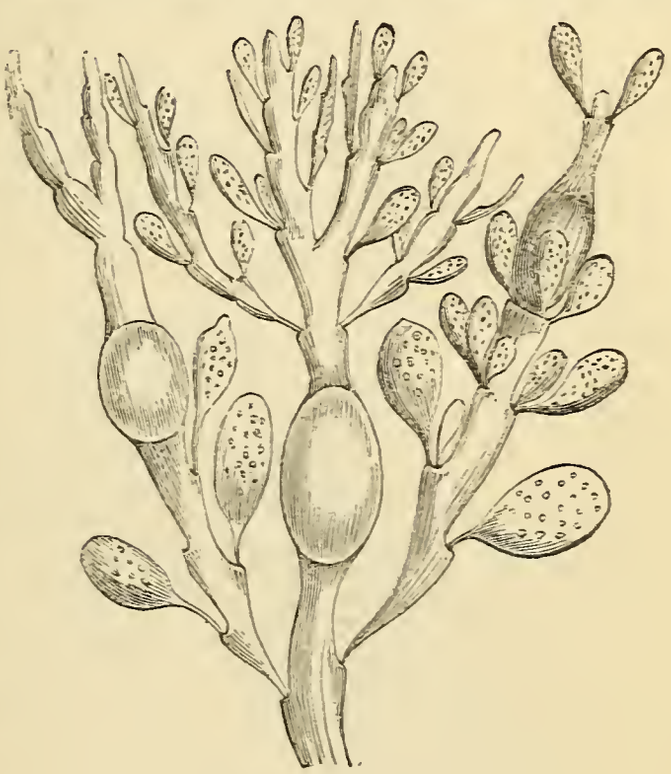
The corallines are not to be omitted from this list of useful plants, for plants they are without doubt. *Corallina officinalis*, *elongata*, and *squamata*, and the elegant *Jania* of both species, *rubens* and *corniculata*, are all elegant, and contrast their light spiny stems against the more palmate forms very agreeably. They last a long while in health, but must be removed if they shew a tendency to become white; for this, though beautiful, is the condition of death.



IRIDEÆ EDULIS.

The following red weeds are also easily domesticated by those who have had some experience, but demand more skill in management than can be given them by beginners:—*Ceramium rubrum*, *Irideæ edulis*, *Furcellaria*, *fastigiata*, *Gymnogonyrus plicatus*, *Gelidium corneum*, *Rhodymenia ciliata*, *Hypnea purpurescens*, *Melobesia pustulata* and *polymorpha*, *Rhodomela subfusca*, *Hildenbrandtia rubra*, *Jania rubens*.

In sea-shore collecting many of the yellow and purple weeds will be found in abundance. Though they all possess certain features of interest, they are of no use in the Aquarium. The common *Fucus nodosus*, which is cast up everywhere abundantly, is of great service as material for packing, and when it has served that purpose it should be thrown into a vessel of clear sea-water, and examined by candle-light, with the assistance of a lens, for the detection of any curious creatures that may have been lurking amongst its fronds. This very distinct alga will always win the attention of those who ramble at the sea-side, and the young people will find amusement in treading on its air-vessels, in order to cause a succession of small explosions. The peacock's tail, *Padina pavonia*, is one of the most curious and beautiful plants the sea produces. It must be dealt with as a temporary inhabitant of the tank, and is in its best place in a large vessel with fishes.



FUCUS NODOSUS.

CHAPTER IX.

"THERE'S beauty in the deep:—
The wave is bluer than the sky;
And though the light shine bright on high,
More softly do the sea-gems glow,
That sparkle in the depths below;
The rainbow's tints are only made,
When on the waters they are laid,
And sun and moon most sweetly shine
Upon the ocean's level brine.
There's beauty in the deep."

BRAINARD.

ZOOLOGICAL NOTES.



THE Marine Aquarium offers facilities for the study of at least twenty out of the twenty-four great classes of animals which exist in the British seas. The marine insecta comprise only a few beetles, but rarely met with, and, when met with, altogether unsuited to the purpose, and of course we must abjure the mammalia. Apart from these two classes all the rest offer representatives. Many of the poriphora, infusoria, and rhizopoda, may be palpably introduced, and many not so introduced will appear in time from germs or even complete specimens originally hidden in tufts of algæ, and among the interstices of serpulæ and other

composite masses. The zoophytes are those which contribute most abundantly to the interest of the collection. After these the echinodermata give a goodly number, as do the annelids and crustaceans, and the several divisions of the mollusca, though the difficulty of preserving many of the last-named, renders it but a small section as regards permanent occupancy of the tank.

ZOOPHYTA.

It is very strange that where the animal and vegetable kingdoms meet, the forms should assume such close resemblances to each other, as to make it frequently a matter of difficulty to determine to which of the two great departments some special specimen shall be assigned. Here are the lovely sea-flowers—flowers only in name and appearance—representing the lowest links of animal life, and pointing to that last link where the animal and the vegetable blend into one, bearing all the outward resemblances to flowers from which they take their appropriate names, yet all of them strictly animals, endowed with volition, and in their general organization assimilating to the extensive series of zoological orders which stand above and beneath them. The sea anemones are animals of the lowest class—*Zoophytes* of the great Cuverian division of RADIATA. It is in this division that animation is seen to tremble and flicker in the socket, and to become gradually extinguished as we descend the scale, and approach the confines of the kingdom of verdure. Here, then, life has its lowest if not least lovely forms; the individuals have less individuality, many of them live in groups and clusters, and increase in a semi-vegetative manner by gemmation, or the formation of bud-like germs, while others generate by spontaneous fissure, and break up into numerous forms,

each of which rapidly acquires the form of the parent, and proceeds in the same way to increase its kind.

The RADIATA are so named on account of the *ray-like* form generally observable in the structure of the creatures; in some the ray-like divisions give such a speciality to the structure as to distinguish them at once as members of this division; as in the star-fishes, for instance, in which the intestinal canal branches out from the body into the several rays which form the star, and in the anemones, in which the relation to the tribe is at first sight perceptible in the *tentacles* which surround the mouth, and which render it so exquisitely beautiful as a marine representative of a true flower.

But though the term Radiata is applied to an extensive division, in which the members have many characteristics in common with each other, the ray-like form is not equally distinguishable in all. In some tribes there is a tendency to associate into groups, in which each individual has a certain degree of connection with the rest, as in the *infusoria* common in our brooks, and indeed most of the *polypes* which thus live in community. The resemblance to vegetable forms is, however, common to a great portion of the Radiata, and those in which this resemblance is the strongest are grouped together under the general designation of *Zoophytes*. In Zoophytes, the leading feature of a radiate animal is very distinctly observable, and that leading feature is the arrangement of the vital organs around a centre, the organs composing the rays of the imaginary star, or the petals of the imaginary flower, to which the mouth or stomach is the *centre*.

Among the Zoophytes we meet with many of the creatures which have the greatest attraction for the student of the Aquarium. The brooks supply him with the

curious hydra, the seven-headed monster that perpetuates one of the triumphs of Hercules—withal a beautiful and wondrous creature, that may be cut in pieces, turned inside out, or even thrust one animal within the other, and still remain the same. The sea supplies the madrepores, the builders of ocean-reefs, and the founders of islands and continents; as it also supplies the sea anemones of more than a hundred species, from the curious *Edwardsia vestita*, to the familiar members of the genus *Actinia*, obtainable everywhere on our coasts.

The true zoophytes have all, more or less, the plant-like form, and they readily separate into two great classes, namely, the *Anthozoa*, or flower-life, and the *Polyzoa*, or many-life, in which the individuals are associated together in numbers. They are all inhabitants of water, are all destitute of joints, lungs, nerves, and proper blood-vessels; but in the place of nerves possess what naturalists call an *irritable* system, in obedience to which they expand or contract at will. At the upper part of the body is situated the mouth, which is usually surrounded with tentacles, which are mostly used in securing prey. In the majority there is no alimentary duct, for the stomach has the form of a simple sac, the aliment being injected and ejected by the same orifice.

The *Anthozoa* comprise animals which are perfect in themselves, and these are mostly soft-bodied, having no shelly covering, and are protected only by the leathery integument which surrounds them, and the thousand weapons of offence and defence which they expand in the form of tentacles. Among the *Polyzoa* we meet with creatures that encase themselves in horny shells, or calcareous coatings, such as the *Madrepores*, which, like submarine masons, elaborate the carbonate of lime which the sea supplies them with, into shelly retreats; and the tubed *Hydrioda*, which construct winding galleries

and convoluted tubes, from the mouths of which they protrude their fans and tentacles in search of prey.

Among the higher orders of the Radiata we meet with the strange Sea Cucumbers and the Sea Urchins, and the Star fishes; and among the lower orders the Sea Anemones, many forms of which are described and figured in these pages.

A Sea Anemone, then, is a Zoophyte belonging to the *class* ANTHOZOA, or flower-life, and the *order* HELANTHOIDA, or sunflower-like creatures. The central disc of the sea-flower is composed of the lips, which open into a mouth which communicates with the simple sac which constitutes the stomach, and the petals and fringes which surround it—now like the anemone, now like the sun-flower or the mesembryanthemum, or the richest carnation that ever won for a florist a golden prize. The further subdivision is dependant on the details of individual structure; and a large section—that of *Actinia*—comprehends most of those on which the aquarian bestows his patience in the work of domestication.

The *Actiniadæ*—so named from the Greek—signifying a ray of the sun—are an extensive family, of which more than a hundred species are to be found on our coasts, or in the deep bays adjacent. But few of these are suited for confinement in aquaria, and of these the chief are the *Actinia* proper, the *Sagartia*, most of which are usually grouped with the *Actinia*; the *Anthea cereus*; the splendid *Adamsia palliata*, which is the only known species of the genus to which it belongs; and a few of the *Bunodes*, *Edwardsia*, and *Corynactis*.

In addition to the reasons already assigned for commencing the study of marine objects with the well-known "Mes," there are others of not less importance, for its habits give us the key to the general management of collections, and its anatomy illustrates the internal con-

struction, and physiological economy, of the whole class of Zoophytes. Take a plump "Mes" that has not been handled, or in any way ill-used, and cut him clean in half, vertically, and drop each half into a vessel of fresh sea-water, that has been agitated well; throw in also a tuft of Ulva; leave the divided victim alone for a week in a very partial daylight, and you will be surprised to find, that each division has become a perfect animal. Then either lift out the specimens into fresh sea-water, or draw off the water they are in, and agitate it in the open air, and return it quickly, and each will at once expand and present as perfect a shape and arrangement of parts, as if their several origins had been distinct, and no relationship existed between them. The experiment illustrates the nearness of this tribe to the vegetable kingdom, and justifies the collective term zoophyte, as applied to the various divisions of this lowest section of the animal kingdom.

In all the varieties of sea anemones the mode of life is similar; they are carnivorous, and obtain their prey by means of the ever-seeking tentacles that search the lymph around them, and secure sometimes fishes, at others mollusks, but more frequently the minute forms of infusorial life that abound in the sea, or in the artificial water of the tank. The mode of reproduction is by ova, which are sometimes vivified in the body of the parent, and not only do they give birth by ejection from the mouth of a numerous progeny, but as just stated in the case of *A. mesembryanthemum*, actual divisions of the body may be made, and each division will acquire completeness. Dr. Johnson relates several instances in proof of this, one of which is particularly interesting. A specimen of *Actinia crassicornis* had swallowed a large, sharp-edged shell, which so completely stretched the body of the creature as if on a ring of

wire, as virtually to cut it into two equal parts. Thereupon it put out from the base a new disc, with mouth and tentacles, and became at once a *double* anemone, to which the gorged shell served as an intermediate base of attachment. Dr. Cocks has seen specimens of *Bunodes alba* acquire complete forms in duplicate when the original specimen has been severed into two or more parts; and there are many other instances on record of this plant-like division of sea anemones having been observed.

Though apparently immobile, there are few species but possess some power of locomotion. We frequently meet with anemones attached to stones, sand, or shells, by a wide sucking base, and if some species be moved from their chosen site, certain death is the result. Yet in by far the greater number there is a distinct faculty of progression—the anemone, by a slow, gliding motion, gradually removes itself, and climbs up the sides of the vessel, or takes possession of a tuft of weed, or shifts from one stone to another, or fairly leaves hold of its anchorage, and floats like a balloon upon the surface. Thus low in the scale as they are, they possess will, and a power of obeying it; they have their organs of locomotion, of attack, and defence; though naked, they are armed for combat on an equality with their enemies, and succumb at last to man—the universal destroyer and appropriator—who turns them to account as food, or treasures them as gems of beauty that gratify his eye, and even win over the affections of his heart, while they lead him to contemplate the variety and profuseness of that *life* to which the Almighty has given so many wondrous forms, and instincts, and economies, every one of which proclaims—

"The hand that made us is divine."

ACTINIADÆ.

In the sub order *Actiniariæ* there are two tribes, 1.—Astræacea, 2.—Caryophyllacea. In the first tribe there are two families, 1.—*Actiniadæ*, 2.—*Lucernariadæ*. In the first of these families we meet with by far the larger majority of the tenants of the Aquarium. At the head of the family stands the genus *Anthea;* there are two species, *Cereus* and *Tuediæ*, the first of which is frequently met with, and may with great care be kept a considerable length of time.

Anthea cereus.—There are several varieties, those most commonly met with are the green of one uniform tint, and green with tentacles tipped with lilac and grey. One leading distinction of the *Anthea* from the rest of its congeners is its incapability of retracting the tentacles within the body, which is the case also with *Adamsia*, which contributes another genus, on account of the annular structure of its adhering base. Mr. Gosse has met with specimens in which the tentacles were almost wholly retracted, but even then the tips were plainly to be seen. As a rule the tentacles remain expanded, though in a sluggish and uninviting form when the animal is sickly, and it dies in the same way. When in good condition the tentacles are finely shewn, and resemble a tuft of wool; they are constantly in motion, and afford every necessary opportunity for minute inspection, which will not be without its reward. It is a voracious creature, and quickly destroys the life of any small creature that approaches it by the stinging power of its tentacles. When seized, the individual character of the Anthea is displayed to advantage, the tentacles being wreathed and contorted in dignified grotesqueness about the prey, which speedily disappears within the body of the creature. This

actinia should as a rule be kept by itself, and its preservation should not be attempted by novices.

Adamsia palliata is the only species of the genus to which it belongs, and it occurs but rarely as the result of dredging. It generally occurs on the mouth of a univalve shell, the common whelk being most frequently selected. Around the mouth of the shell it extends its adhering base, till the two sides meet, and unite with a suture. It thus forms a rude fleshy annulus, through the orifice of which a hermit crab finds sufficient room to sprawl out his claws in search of prey, the hermit occupying the interior of the shell, and the leathery *Adamsia* standing guard at the door. It is very difficult to keep for any length of time.

Corynactis. The three well-known species of *Corynactis* respectively named *viridis*, *Allmanni*, and *hetorcea*, are beautiful actinia of minute size, and thoroughly hardy in confinement. They usually occur in clusters on blocks of sandstone, and should on no account be disturbed. They may be distinguished from the young of any other genera by the globose tip which terminates each of the tentacles. In other respects their cylindrical form, adherent base, and general habits agree with their larger congeners. The blocks to which they are attached, should be placed near the front glass, for convenience of inspecting them with a lens or microscope.

SAGARTIA.

Mr. Gosse has instituted this genus in order to class together those actinia which emit "capsuliferous filaments from pores." It includes *viduata*, *(anguicoma,) troglodytes*, *aurora*, (which I believe to be a variety of the preceding,) *candida*, *(sphyrodeta,) rosea*, *nivea*, *venusta*, *parasitica*, *bellis*, and *dianthus*. The last-named has since been separated, and is now classed as *Actinoloba dianthus*.

Sagartia anguicoma.—One very striking characteristic of the sea flowers, is their capability of changing their forms, and this is in no species so powerfully exemplified as in *Sagartia anguicoma*, of which there are three specimens, in different stages of expansion, represented



SAGARTIA VIDUATA, (ANGUICOMA.)

in the cuts. This is a most valuable Aquarium species, and may be preserved for any length of time, if properly tended. It has one bad habit, and that is, that it will frequently let go its foothold, and lay prostrate on the pebbles, so that the slightest agitation of the water may spin it into some crevice among the rock-work, or send it bouncing against the glass sides. This, however, only occurs when there is a deficiency

of oxygen, and the occurrence should be a signal for aeration. Its colouring is very quiet—grey, buff, pale brown, and opal white predominate; and the markings of the disc are generally pleasing and delicate. Its



Sagartia viduata, (anguicoma,) Trochus ziziphinus, Ulva latissima, Bryopsis plumosa, Acorn barnacle.

long flexile tentacula catch the eye of the most indifferent observer, and the patient watcher finds his reward in its many extraordinary changes of form. When you receive specimens packed in wet sea-weed, they are like little buttons of dirty white gelatine, but in less than half an hour after you drop them into the tank, they throw

up their tall stems, and expand their long delicate tentacles in most various ways, so that among fifty specimens there will not be two alike; and yet in every stage of presentation, there is not the slightest difficulty experienced in determining what they are. Sometimes they take it into their heads to lie at full length altogether unattached, now contracting themselves to a mere pimple, then blowing out the disc, and contracting the base, and at other times assuming a regular spiral form, like a fleshy corkscrew; but the tentacles are almost always expanded, be the shape of the creature what it may.

S. bellis, the daisy, certainly does resemble a daisy very closely indeed. Though much prized it is not rare. Mr. Lloyd usually has abundance of them on sale, at a shilling each, and a few should be used to give variety to the collection. In newly-made marine water it will not do at all; but if it falls into the possession of an aquarian who has no ripe tank at hand for it, it may be kept for weeks in a shallow pan. If anything goes wrong with this kind, it throws out a number of white threads, and shrinks out of form, and perishes in a few days; but once obtained in a sound state, and carefully treated at the outset, it is as hardy as *mesembryanthemum*, and more readily expanded at all seasons than most of its compeers. It is also the most prolific and the most variable in colour of the whole tribe, and is almost always expanded.

Sagartia parasitica—This is a good Aquarium species, on account of the ease with which it may be kept at all seasons, except during very hot weather, when it is advisable to remove it in a vessel by itself into some cool underground apartment, where with an occasional change of water it may survive the attack of heat, and may be returned to the Aquarium when the temperature

has declined. It is a species that the rambler on the sea-beach will not be at all likely to meet with, for it is truly *pelagic* in its habit. It is only to be obtained in a state fit for the Aquarium by means of the dredge, and when so obtained it lives a long while in confinement. The most interesting feature in the history of this zoophyte is that of its usually inhabiting the shell of some defunct univalve mollusk, such as the *Trochus* or the great whelk, *Buccinum undatum*. This is not the most curious part of its history. The anemone loves company, and in the same shell as that on which it extends itself, we usually find a pretty but pugnacious crab, *Pagurus bernhardus*. To the anemone the crab acts as porter; he drags the shell about with him as if it were a palanquin, on which sits enthroned a very bloated but gaily-dressed potentate, destitute of power to move it for himself. Like most lazy dignitaries, this showy actinia attracts more attention than the lively servant who drags it from place to place, for its form and colouring are beautiful in the extreme.

It is of large size, frequently attaining to a height of four inches, with a diameter of two and a half. Mr. Gosse's description of this fine creature is so minute and interesting, that I must beg the reader to accept it in preference to any that I can write. He says, the "ground colour is a dirty white, or drab, often slightly tinged with pale yellow; longitudinal bands of dark wood-brown, reddish, or purplish brown, run down the body, sometimes very regularly, and set so closely as to leave the intermediate bands of ground colour much narrower than themselves; at other times these bands are narrower, more separated, and variously interrupted or broken. I have seen a variety in which the bands took the form of chains of round dark spots, the effect of which was handsome. Immediately round

the base the bands usually subdivide, and are varied by a single series of upright, oblong spots of rich yellow, which are usually marginal, with deeper brown than the bands. The whole body is surrounded by close-set faint lines of pale blue, sometimes scarcely distinguishable, except near the summit, where they cut the bands in such a manner as to form, with other similar lines which there run lengthwise, a reticulated pattern.

"The disc is somewhat wider than the diameter of the body, which it over-arches on all sides. Its margin is somewhat thin, and occasionally thrown into puckered folds to a small extent. Thus it appears to approach the peculiar form of *A. bellis*. The disc is nearly flat, or slightly hollowed, but rises in the centre into a stout cone, in the middle of which is the mouth, edged with crenated lips. The tentacles are arranged in seven rows, of which the innermost contains about twenty, the second twenty-four, the third forty-eight, the fourth ninety-six; the other rows are too closely set, and too numerous to be distinguished. Probably the whole number of tentacles, in a full-grown specimen, may be considered as certainly not less than five hundred."

S. dianthus, (Actinoloba dianthus.)—The crowning glory of the Aquarium is the superb plumose anemone, *S. dianthus*. It is the monarch of the tank, and for magnitude and splendour of colouring throws all other anemones into the shade. Neither does it so strictly belong to what may be termed *ground stock*, for though it conforms to the orthodox rules of Zoophytic life, it is so free in its actions, and exhibits so much individuality in its habits, as to appear to be endowed with higher faculties than its more humble brethren. It seldom remains for any length of time at the bottom of the vessel, but slowly glides along till it meets with some perpendicular surface, such as a block of stone, or the side of

the vessel, and during the night it ascends and takes up its position midway between the bottom and the top of the vessel. When it has fairly settled itself, it is not slow to exhibit its magnificent proportions and glorious purity of colouring. Pure milk white, pale amber, rich gold, or warm salmon colour, are its prevailing tints.

Full-grown specimens have a height of six inches, and a diameter of one and a half when they stand upright, and even when only four inches high their appearance is massive and grand. When expanded the tentacles spread over in thousands, and form huge fringing masses that strongly resemble the petals of double carnations; they are ever in motion, like

"Meadows fanned by heaven's life-breathing wind."

They expand outwards, droop over the column, then retreat and assume a cup-like appearance, then fall over again and wave with a slow vibratile motion, as if

"Seeking something which they cannot find;"

and when they once more close together, the creature shews a new caprice by suddenly shrinking down into the form of a balloon, distended to a huge sphere, which presently seems clasped by a cord, and the balloon is cut into two equal halves. The zone of constriction shifts from place to place, increasing the bulk of one sphere at the expense of the other, until it seems as if it slipped off at the base, when the column starts up again, rises to its full height, and the thousands of fringes again extend and wave to and fro as before. The slightest shock against the sides of the vessel, or a mere breath upon the surface of the water is at any time sufficient to alarm the beauty, and cause it to withdraw its tentacles, but they are soon put forth again, and are invariably in a state of expansion.

This has been described as one of the most tender of

its class, but I have long been convinced that it is comparatively hardy, and may be preserved with very great certainty. So long as the water is kept moderately pure, by an occasional filtering, it lives and prospers, occasionally moving from place to place, but almost always expanded, and every instant assuming some new form. It is, however, so far delicate that, if frequently disturbed, it is sure to perish. When removed from its native "oozy bed" it should be kept on the stone or shell to which it is found attached, until it floats off of its own accord, and fixes itself elsewhere. When handled it throws out a number of white threads, which are afterwards withdrawn. Those which have very fine tentacles are the most permanently expanded; the variety in which the body has deep creases, and the tentacles a coarse character, will remain closed for days together.

BUNODES.

This also is a genus instituted by Mr. Gosse, and includes those actinia which have a cylindrical body studded with warts, skin leathery, not emitting missile filaments; the tentacles are generally thick, conical, and obtuse. The genus at first included *gemmacea*, *thallia*, *clavata*, *crassicornis*, and four others of questionable identification; *crassicornis* has since been removed into another genus as *Tealia crassicornis*.

Bunodes gemmacea.—This is a delicately constituted anemone, that displays itself freely only in the most pure sea-water, in which there is abundance of oxygen. It is quite unfit for early experiments, but well repays the trouble it occasions when it can be successfully kept. I have frequently had the pleasure of witnessing the birth of large clusters of this pretty anemone in my own vessels, and believe it to be almost as prolific as

the daisy. To the naked eye they appear mere flocculent specks, but a lens reveals their true form as they adhere to the side of the vessel; every one of the little creatures, with its tentacles expanded, a real microscopic gem, combining the grace of a flower with the tinting of a pearl, and the delicate volition of a new-born animal. When



Sagartia bellis, Bunodes gemmacea, Delesseria alata, Polysiphonia urceolata.

full grown, the gemmed anemone is very showy in its tintings. Pink, yellow, and grey are beautifully blended, and the rows of glands which reach from the margin to the base, add their dots of white to the garments of this tiny harlequin. The disc is brilliantly coloured, scarlet, green, and orange, shading into each other, and occasionally mingled with half-tints of every colour

of the rainbow. The lip is usually of a vivid green, and the tentacles exhibit rose, violet, orange, and white on their upper surfaces. In the cut, this anemone is seen partially closed on a piece of stone behind two specimens of *S. bellis*. *B. clavata* is a hardy species, and should be kept with the gem. It is easily distinguished by the clubbed form of its tentacles.

B. crassicornis is one of the most delicate kinds, that dies speedily, unless treated with great care, and in a well-established tank. It is very abundant on every part of our coasts, and must be removed with the stone to which it is found adhering; for if removed, or even handled, it perishes in the course of a few hours. It is, however, too beautiful not to be worth an effort to preserve it; and, if the tank is in good condition, it will be well to obtain two or three specimens, and watch them narrowly, so that if any of them die, they may be immediately removed to avoid polluting the water. The colour of this anemone varies considerably in different specimens. Violet and amber shades frequently predominate in the tentacles. Sometimes the disc is of a pearly white, at others of a warm fawn or bright orange and scarlet, sometimes a deep crimson or a dull chocolate; while the tentacles, which are very numerous and tubular, vary from pure white to dark brown, dingy fawn, and brick-dust red. When irritated, the creature has the power of attaching the tentacles to the object which annoys it, and in this way it frequently clings to the fingers when handled, and at the same time squirts out numerous jets of water, until it is quite empty and collapsed. It is very voracious, and must be liberally fed. It is best kept by itself in a large shallow vessel well sustained in oxygen.

ACTINIÆ.

This Linnæan genus has been tremendously reduced by the recent classification of its species in accordance with their physiological characters, of which but little was known previous to the establishment of the Aquarium. The distinctive features of the genus are a cylindrical body, destitute of warts, of pores, and of missile filaments; the skin is smooth, and at the margin of the disc is a series of capsuliferous spherules, which give so peculiar a beauty to the common strawberry anemone.

A. mesembryanthemum is the common Smooth Anemone which abounds on every part of our coast. Its colour varies considerably, but it is usually of a deep, warm chocolate, dotted all over with small yellow spots, and when closed has the best possible resemblance to a large ripe strawberry. Every stone about the sea-beech is studded with this anemone, and a collector may secure any required number in a few hours, slipping each from its base, and dropping the whole into a jar with some fragments of fresh weed to keep them moist. When it expands, a circle of bright blue beads or tubercles, resembling torquises, is seen just within the central opening; and, as the expansion proceeds, a number of coral-like fingers, or tentacles, unfold from the centre, and at last spread out on all sides like the hundred petals of a Peri flower, reminding one of Hinda's boon :—

> ———Be it our's to embellish thy pillow
> With everything beauteous that grows in the deep ;
> Each flower of the rock, and each gem of the billow,
> Shall sweeten thy bed and illumine thy sleep.
>
> Around thee shall glisten the loveliest amber
> That ever the sorrowing sea-bird has wept,
> With many a shell in whose hollow-wreathed chamber
> We, Peris of Ocean, by moonlight have slept.
>
> LALLA ROOKH.

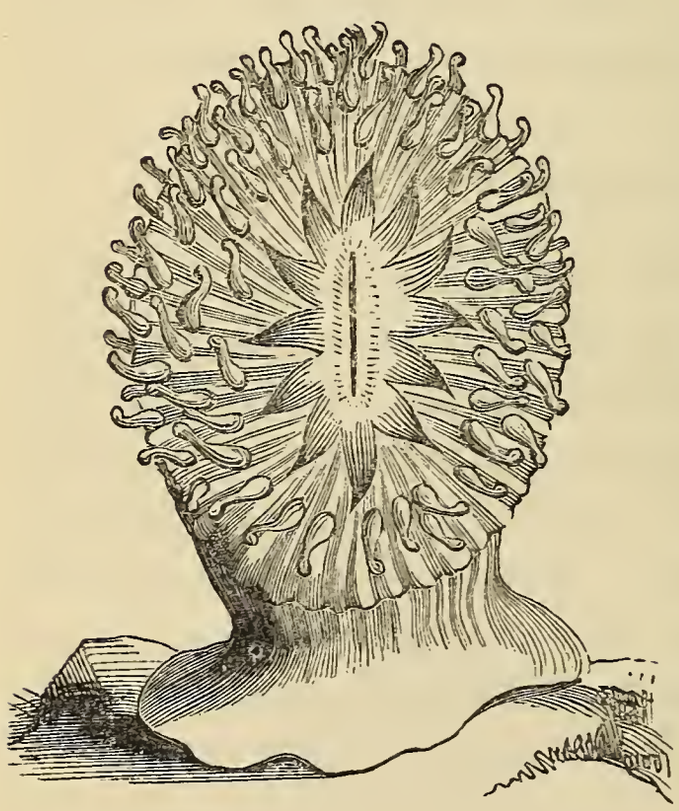
This anemone will remain expanded for many days together, if the water be kept bright and pure; but if the tank gets fouled, it closes and falls from its foothold, and perishes if not attended to. It is the hardiest of all the creatures that are regarded as stock for tanks, and survives many a wreck unhurt. To induce it to climb up the sides of the vessel, let it be placed with its base lying partly against it, or bring it close to a stone in the centre, and it will be pretty sure to attach itself where you desire in the course of a few days. This last suggestion applies to anemones generally; novices are surprised to find how well disposed the creatures are in a well-kept tank. The disposition dates from the day of introduction, for few of this tribe are fond of locomotion; and the arrangement of them for effect, depends upon whether you drop them quietly just in contact with the spot you wish them to adhere to, or throw them in pell-mell, to cling to the weeds or to each other. The other species of the genus Actiniæ are *margaritifera* and *chioccocæ*, both of precarious existence in the tank.

CERIANTHUS.

This is a new genus in which is placed that very interesting creature, the clothed sea anemone, formerly named and best known as *Edwardsia vestita*. The body is not adherent, and the mouth and tentacles are seated on a retractile column. In 1841 the late Professor Forbes communicated to the "Annals of Natural History" an account of two curious marine animals found in the Ægean Sea, one an annelide, (*Amphitrite Ægeana,*) the other a polype, provisionally named, in commemoration of M. Milne Edwards, *Edwardsia*. This polype is a worm-shaped actinia, which constructs for itself a leathery tube to live in, from the open end of which it pro-

trudes its tentacled head, which has the appearance of a star furnished with two circles of rays, those on the outer circumference being the largest, and the whole arranged in geometrical accuracy, radiating from the mouth in the centre. This, at first supposed to be a rare example of marine life, had no sooner been described than it was discovered to be by no means rare in the English Channel, and on the west coast, and I had the opportunity of seeing the first which was sent up to Mr. Lloyd, at Portland Road, and from which I made the very rude sketch which appears at page 49. It has since been most accurately and beautifully figured by Mr. G. B. Sowerby, in his "History of the Aquarium," and also figured and described by Mr. Gosse, in his most valuable work on "The British Sea Anemones."

CARYOPHYLLACEA.



CYATHINA SMITHII.

In the section of *Caryophyllacea*, depositing a corallum, the most important to the aquarian is *Cyathina Smithii*, formerly called *Caryophyllea Smithii*, the most hardy and most plentiful of all the madrepores. This species occurs in both simple and compound forms, and in several shades of colour, from pale straw to vivid green, the last-named being the most difficult to preserve. Those who

have means and leisure for the minute study of marine life would do well to appropriate to the madrepores a small slope-back tank at some distance from a window, and so placed that instead of the light falling from above only, it would reach the rock-work through the front plate. On several occasions I have found madrepores to prosper in such a position, where, facing the window and not very near it, they are admirably situated for inspection by means of lenses and microscopes. *Balanophyllea Regia* is generally met with in fine composite masses, in which there are individuals in every stage of development. *Oculina prolifera* is the most truly coral-like of any of them, though the least easy to preserve, nevertheless, in a tank placed as above stated, and devoted only to this class of zoophytes, it may be kept in health for months.



The *Alcyonidæ* and the *Acalepha* offer but few subjects that suit the purpose of the aquarian, though in sea-side studies the medusas and beroes claim the fullest attention of the zoologist, no less on account of their forms and metamorphoses, than their physiology and relationships. In "Recreative Science" for July, 1860, are some original observations on the transformation of *Hydra tuba* into a true medusa, by Mr. A. Ramsay, which merit the attention of naturalists, as offering important points for determination and comparison by experiment. The *Alcyonium digitatum*, and many species of medusa and cydippe, come to hand pretty frequently among the gatherings of the dredge, and some occasionally appear as the produce of the tank, being introduced with the sea-water, or developed from germs in the algæ.

None of them live long, and therefore it is advisable to place them as soon as detected, or obtained purposely, in separate vessels, and there give them every possible chance of enduring confinement. We meet with many more tenants of the tank in the great class

ECHINODERMATA.

The term *Echinoderm* is sufficiently descriptive to enable any one to assign to this great class any of its more definitely characteristic members; but, as in the case of the mollusks, in which class there are many without shells, so among the echinoderms there are many that are not "hedgehog-skinned." Usually they are clothed with prickles, and the star-like or "radiate" form largely predominates amongst them. The star-fishes are the most representative as types of the class as to form, and the sea urchins as to the spiny character of the external envelope. The possession of suckers is very characteristic of the family, and if a star-fish be observed from below as it ascends the side of the glass dish, their structure and action will be seen in the most distinct form presentable by any of the class. In the sea urchin the suckers are protruded from the whole series of pores, which radiate in five pairs of lines from one axis to the other of the animated sphere. In a moderate-sized urchin there are, according to Professor Forbes, one thousand eight hundred and sixty of these suckers. Mr. Gosse has written the best brief summary extant of the physiology of this interesting family, in his introduction to the enumeration of genera and species, in the first volume of his "Manual of Marine Zoology," and to Professor Edward Forbes we are indebted for the only classical work on British species, and that perhaps the greatest of his great undertakings, the "History of British Star-fishes."

ASTEROIDEA.

There are two great divisions of the star-fishes,—the *Ophiuradæ* and *Asteriadæ*. In the first the long snake-like rays are appended to round, depressed, urchin-like discs, and the locomotion is performed by spines. In the second the angles or rays are not appendages, but parts of the body, and the locomotion is by means of suckers protruded from beneath the rays. The species of *Ophiuradæ* most commonly met with are *Ophiura texturata*, *Ophiocoma rosula*, and *minuta*, and *Astrophyton scutatum*; all of them difficult to preserve, and under the best circumstances short-lived. Of the *Asteriadæ* there are several that may be kept with more certainty, and the following may be considered as the best:—*Uraster rubens* and *hispida*, *Cribella oculata*, *Solaster endeca* and *papposa*, *Palmipes membranaceous*, and *Asterina gibbosa*. The last-named is the hardiest and smallest of British star-fishes, a most interesting creature in a shallow vessel, and one which may be kept in quantity when so procurable, which is the case frequently. Their voracity adds to their other attractions, and when well fed they are full of action, and their locomotive progress offers a pretty subject of observation for the microscopist.

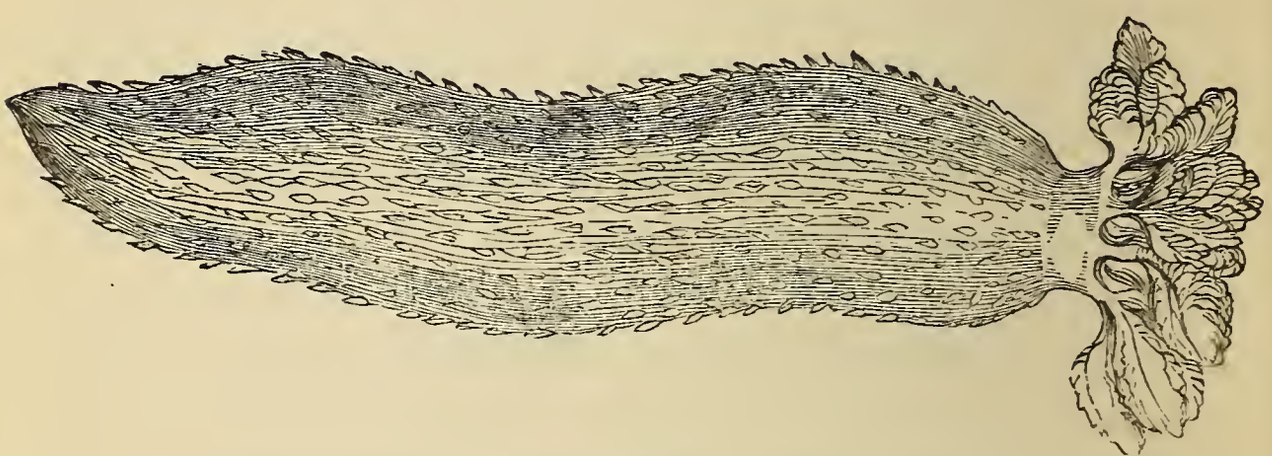
> "The prickly star creeps on with full deceit
> To force the Oyster from his close retreat,
> When gaping lids their widened void display,
> The watchful star thrusts in a pointed ray.
> Of all its treasures spoils the rifled case,
> And empty shells the sandy hillocks grace."
>
> OPPIAN.

ECHINIODEA.

Among the three sections of this order the only species likely to prosper in tanks, so far as our present experience goes, are *Echinus sphæra*, *E. miliaris*, and *Cidaris papillata*.

HOLOTHUROIDEA.

The sea cucumbers are largely adopted into the Aquarium family, for they live long, endure confinement with patience, and have almost entirely given up that baneful tendency to suicide, which possessed them when the study of the Aquarium was in its crude commencement.



HOLOTHURIA.

The improvement in the construction of tanks, and the admitted value and necessity of the lower forms of algæ, have brought about conditions favourable to their preservation, and they may now be considered as easily manageable as the generality of actinia. *Pentacta pentactes*, *Ocnus brunneus*, *Holothuria nigra*, and *H. tubulosa* are especially recommended to the notice of beginners. In the order *Sipunculoidea* we have *Sipunculus Bernhardus*, and *S. punctatissimus*, both of which are of great hardiness, and afford an opportunity of observing a peculiar section of echinoderms.

ANNELIDA.

Among the *Annulosa* there are none that the beginner dare touch, but the sea-side explorer must secure as many as possible, in order to see in what respects they

differ from the true annelids, with which they have been confounded. They also afford interesting studies of vibratile cilia, the surface of the body being entirely clothed with them. The annelids are in the strictest sense, *worms*, and whether the aquarian take them in hand as a separate subject of study, or pass them by altogether, he is sure some time or other to make acquaintance with some of them, for specimens will occasionally crawl out of shells containing hermit crabs, and composite masses that have been much mined generally present specimens of *Serpulæ* and *Terebellæ*.

The common earthworm may be regarded as the type of the *Annelids*. A very large number of these marine worms find their way into our marine vessels, and their exquisite beauty and distinctiveness render them welcome inmates. Some, indeed, come there by accident, for specimens of *Nereis* and *Syllis*, which closely resemble the common millepede of the garden, frequently crawl out of shells, containing hermit crabs, and, finding their way down among the pebbles, keep up a writhing action on the bottom, and generally live for two or three months —thongh you may not happen to see them for weeks after having introduced the hermits. Frequently the presence of a *Nereis* in a whelk shell is made known at feeding time, when a mysterious worm-like head pops out from behind the crab, and snatches the choice morsel from his mouth, and then instantly withdraws to masticate the stolen dainty in secret. At other times specimens of the family are found completely covering an old shell which you may have received with an *Actinia*, or with a tuft of *Algæ*, but these are the masons of the family which construct cavernous recesses on the surfaces of shells and stones.

It is well to examine with a lens the rough shells and stones in the tank, especially if the latter are soft sand-

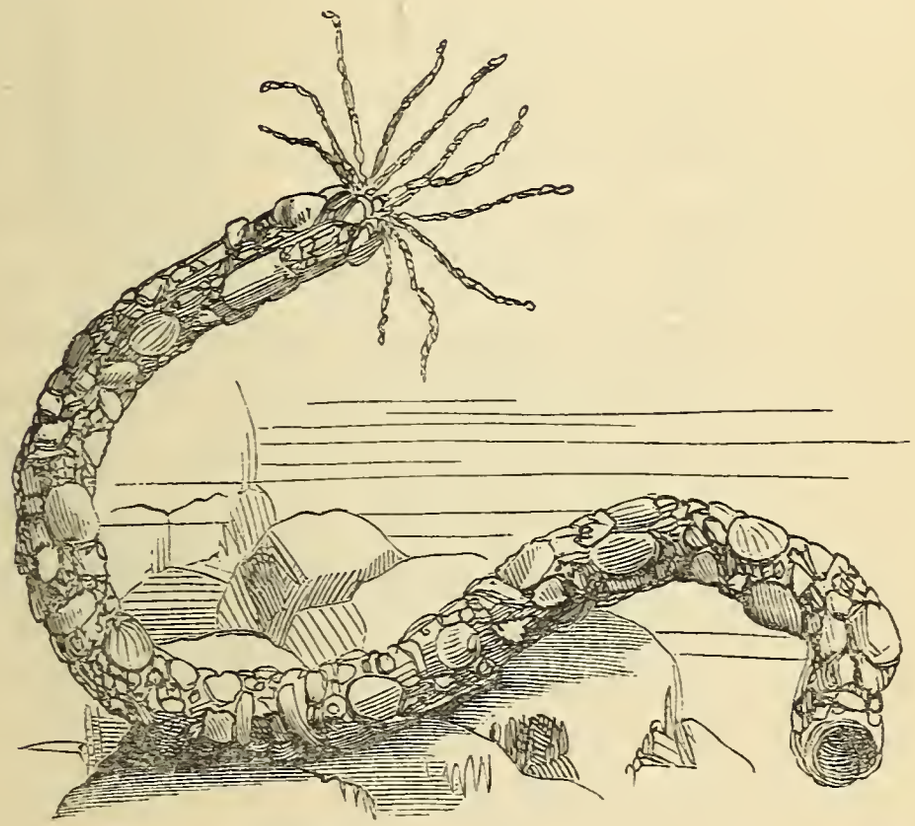
stone, to discover if they are not studded with little feathery fans all over the surface ; as you will, probably, find yourself the possessor of dozens of pretty creatures which have come to you accidentally and gratis, for these creatures abound not only on objects dredged from deep water, but on ordinary shoal gatherings. I find immense numbers of *Sabellæ* and *Terebellæ* on half-rotten fragments of sandstone that come to me from the south coast, well covered with *Ulva latissima*, and which, owing to its rapid decay in the tank, the red fragments continually crumbling from it, would be a perfect nuisance, were it not honeycombed with myriads of the beautiful worms which afford one much amusement in the use of a lens.

All these worms are formed on the principle of a centipede, that is, the body is composed of successive rings, or annular joints, so that they are enabled to contract and expand, lengthwise, at pleasure. The first joint is the head, to which is appended the branchial frills, the protrusion of which gives such attractiveness to the shells on which the colonies have established themselves. The other joints are usually furnished with feet-like processes, that enable the animal to creep forward to the mouth of its tube, or retreat back again when alarmed. In the *Dorsibranchiata*, of which the *Nereis* is an example, the gill tufts are associated with these bristles ; but in the *Tubicola*, represented by the *Serpulæ*, they are attached to the head.

The most popular members of the family of marine Annelids are *Serpulæ*, of several species, *Terebellæ*, *Sabellæ*, and the famous sea mouse, *Aphrodita aculeata*.

Sabella alveoluta is, decidedly, a sandworm ; it constructs a congeries of sandy tubes, which so regularly cross and interlace, as to prove a very perfect honeycomb ; and it prefers a flat surface for its operations,

and lives in colonies of thousands of individuals. Some of the caves that are accessible on the coast, when the spring tides are out, may be found entirely mined over by this industrious creature, and if a block of the loose material is placed in the tank, it will be seen to be regularly dotted all over by their expanded gills, resembling, at first sight, a prolific birth of young gemmaceous *Anemones*.



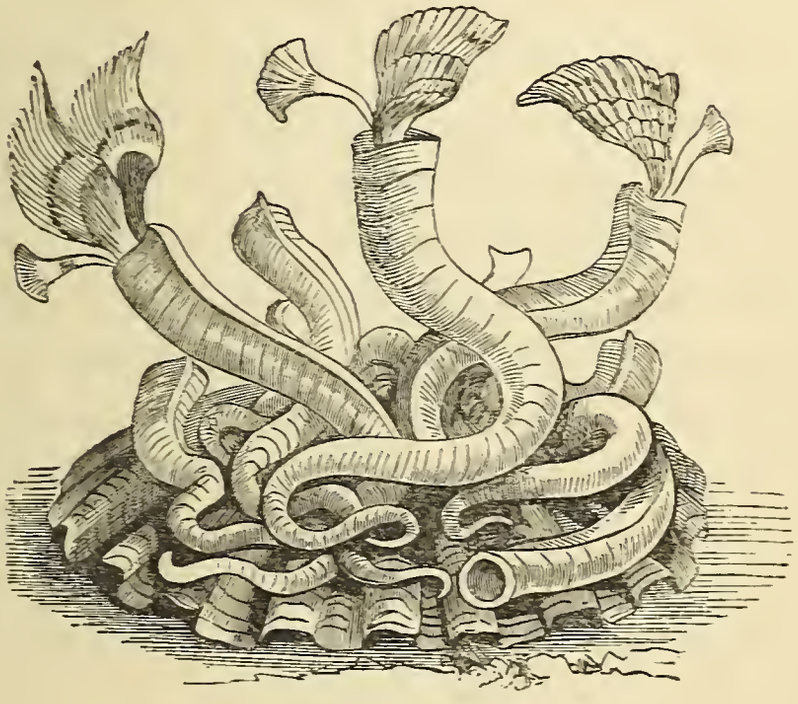
TEREBELLUM CONCHILEGA.

Terebella conchilega likes a harder material, and usually builds his tube of minute pebbles, grains of sand, and small shells, which he cements together in just the same way as the Caddis worm. These tubes are very brittle, and are pretty sure to undergo some amount of damage in collecting them ; but, unless the creature within also suffers injury, the damage is soon repaired. Between these two animals, the differences of habit and structure are sufficiently striking to enable the most inexperienced

observer to distinguish them. The *Sabellæ*, like the *Serpulæ*, display a pretty comb of gills; but the *Terebellæ* carry an *Actinia*-sort of head, adorned with slender tentacles, wreathed, as it were, with snakes. It is also locomotive, and will sometimes leave its tube and mount the glass by means of its tentacula, and sometimes it will travel along the surface of the water with its body in a vertical position, the tentacles holding to the stratum of air at the surface, on the plan of walking on a ceiling.

Serpulæ are the most attractive, and for beauty of form and colour, are not to be put in the shade by the most beautiful of the sea-flowers. If you watch, after having allowed a specimen some little repose, you will see it thrust forth a pair of bright coral fans, right and left, and between these is an elegantly-formed trumpet of the same dazzling coral hue. The species is *Serpula contortuplicata;* it is very abundant, and, hence, easily procurable, and with very moderate care proves hardy and long-lived. The way in which this *Serpula* usually constructs its stony tube, is to lay it close to the stone or shell to which it is attached, the greater part of its length, and then to turn it upwards, so that the last few rings are elevated perpendicularly. On examining a bunch of these tubes, and they are generally involved in curious twistings, many together, the successive additions may generally be counted from the narrow beginning to the last expanded annulus, from which the creature displays its lovely fans and stopper, in the same way as we can count the lines of growth on the shell of a mollusk, and especially in the shell of the oyster. The pretty fans are the breathing organs, and, under a lens, their construction is seen to be on the plan of a series of combs, and it is an easy matter to detect their relationship to the branchial appendages of other aquatic creatures. The casual observer will easily learn the use of

the neatly-formed trumpet, for the mere passage of the hand before the glass, or above the surface of the water, is sufficient to alarm the newly-caught *Serpula*, who, in an instant, closes up his fans, and withdraws into the tube, to which the trumpet acts as a stopper. On close examination, another trumpet will be discovered, associated with the one which plays this conspicuous part in the animal's movements, but it is undeveloped and mi-



SERPULA CONTORTUPLICATA.

nute, the visible one serving the purpose to which it is put, and fitting closely inside the mouth of the tube. Whatever may be said about taming creatures which seem so destitute of intelligence as sea-worms, the *Serpulæ* certainly change their habits somewhat in confinement, and instead of withdrawing on the slightest alarm, even of a footfall, or the passing of a shadow over the vessel, get at last quite bold, and remain expanded, in spite of small disturbances. At first it is quite impossible to examine them minutely, owing to their timidity ; but after a while, they will give the student every opportu-

nity for applying a lens to them, and there are few subjects more worthy of a close scrutiny.

In common with other tube worms, and with hermit crabs, the *Serpula* usually leaves his home to die. A sudden alarm, or a long-continued foulness of the water, will sometimes cause him to throw off the trumpet; but this act is not always followed by immediate death. I have had specimens that lived a fortnight after the stopper had been ejected, but I have never either heard of, nor seen, an instance in which the organ had been reproduced. If the rejected stopper is removed from the tank, it is found to be rigid and horny, and it retains its form and colour for weeks after dismemberment, shewing that there is little decomposable material mixed up with its cartilage. When the worm comes out and concludes its career, its relations to the *Annelids* are easily detected, the long worm-like body is formed of a series of rings, and it terminates in a blunt point, slightly curved. Mr. Sowerby very lucidly describes the organs by means of which the animal traverses the tube, and if an examination be made immediately after death, these may be distinguished and counted, so as to furnish a pretty zoological study. He says, "How does the *Serpula* manage to creep up and down his shelly tube so rapidly, withdrawing so instantaneously when alarmed or disturbed? Along the sides of his body are seven pairs of tubercles, with a bunch of bristles in each, which may be pushed out or withdrawn. Each bristle, when microscopically examined, is seen to be a transparent, horny, yellow shaft, the extremity of which dilates into a slightly enlarged knob. This is cleft into four points, three of which are minute, but the fourth is developed into a long, slightly divergent, highly elastic, tapering, and finely-pointed spear. By pushing these bristles against the sides of the tube, and prizing up the body by their means, the upward

movement is effected. The retreating motion is performed by a minute, ribbon-like muscle, on which are fixed many thousands of hooked teeth, which firmly hold to the inner lining of the tube, while the muscles contract with a jerk, and draw the animal down."

The *Serpulæ* may be kept with any kind of marine stock, for they have no bad habits, and they are not liable to injury, even when crabs sprawl over them, owing to the impenetrable retreats in which they so readily ensconce themselves when alarmed. I have had them survive a wreck caused by putrescence and increase of density; but, as a rule, the water should be bright and pure, and well regulated as to strength, and abundantly supplied with oxygen, for them to do well.

Aphrodita aculeata.—The sea mouse is one of the rarest gems for special consideration which comes within the range of our operations, in taming the tenants of the sea. The exquisite beauty of iridescent colouring is unsurpassed, and every varying degree of light under which it is seen, gives it a new character, and a new interest. I have already in the chapter on management made special remark on the mode of preserving this interesting creature, which I have obtained frequently when collecting on the south coast, and have succeeded in preserving with a considerable degree of certainty. In his elegant volume on "The Aquarium," Mr. Gosse gives so graphic an account of this curious creature, that I cannot refrain from quoting it entire :—

"It is not in its form that we must look for any peculiar elegance, for it is a flattened worm, of an oval outline bluntly pointed at each end;—nor in its general colour, for this is that of the pale brown sediment that water deposits. But it is in the clothing of long silky hair which covers each side, and which reflects the most brilliant and refulgent hues, equalling the splendours of

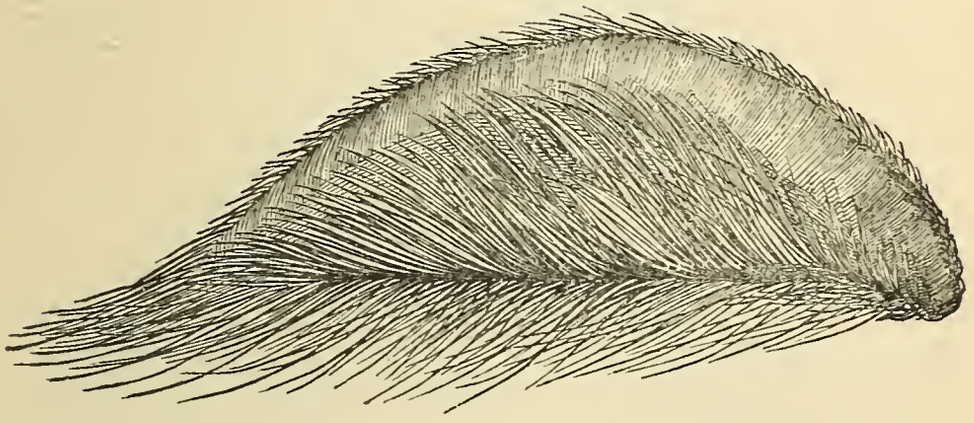
the Humming-birds, or the Diamond-beetles." Hence Lamarck gave it the appellation of *Halithea*, or Sea-goddess; and Linnæus before him had conferred on it the name of the goddess of beauty, *Aphrodite*, the Greek title of Venus. The great master of Natural History thus expresses his admiration of the sea-worm: "The *Aphrodite aculeata*, reflecting the sunbeams from the depths of the sea, exhibits as vivid colours as the peacock itself, spreading its jewelled train."

In the Aquarium the Sea-mouse crawls restlessly to and fro, and round the margin of the bottom; once or twice I have seen it essay to burrow under the fine gravel, but generally it lives exposed. It is uninteresting in its manners, though the brilliance of its changing colours will always attract admiration. Perhaps it is most beautiful by candle light, when red and orange reflections predominate; by day, pearly greens and blues prevail. This difference is owing to the position of the light, and the angle at which it is reflected. Thus, if the eye glance along the bristles towards the light, which is reflected at an obtuse angle, the reflected rays will be lilac, passing into ultramarine; if the angle of reflection be a right angle the rays will be green; if the light be between the observer and the animal (not directly but obliquely, so as to make the angle of reflection more or less acute,) the reflections will take yellow, orange, scarlet, and crimson hues.

As it crawls, the *Aphrodite* usually elevates the tail, which is so folded together as to form a deep groove beneath. By watching this we see now and then ejected a stream of water, with considerable force. I found that the jet occurred once in twenty-five seconds, with punctual regularity. This is a respiratory act; the grooved orifice through which the jet is poured is not the termination of the intestine, as we may at first suppose,

but the exit of a capacious chamber which is external to the body, though concealed.

A very marvellous and quite unparalleled structure here comes into view. If we take a sea-mouse into our hand, we see the whole breadth of the back occupied by a woolly substance, closely resembling felt, and formed by the interlacing of fine hairs. If we insert a pen-knife into the tail-groove and slit up this felt-like cover, we expose an ample cavity running the whole length of the



APHRODITE ACULEATA.

animal, the floor of which is the true skin of the back, on which are set two rows of large overlapping plates or membranous scales *(elytra.)*

The dense tissue of interwoven hair resembling felt acts as a filter for the water to be respired, straining off the earthly particles held in it, which thus accumulate in its substance, and impart that peculiar dirty appearance which it possesses. The scales, according to Dr. Williams,* are periodically elevated and depressed. In the former action, the water permeates the felt, and fills the vacuum formed between them and the back. As soon as it is full, they collapse, and the filtered fluid, now deprived of its oxygen, is forcibly expelled at the anal groove. Well may the adoring Psalmist include

* Report on the British Annelida, 200.

among "the riches" of God, the "things creeping innumerable, both small and great beasts," wherewith "this great and wide sea" is filled!

CRUSTACEA.

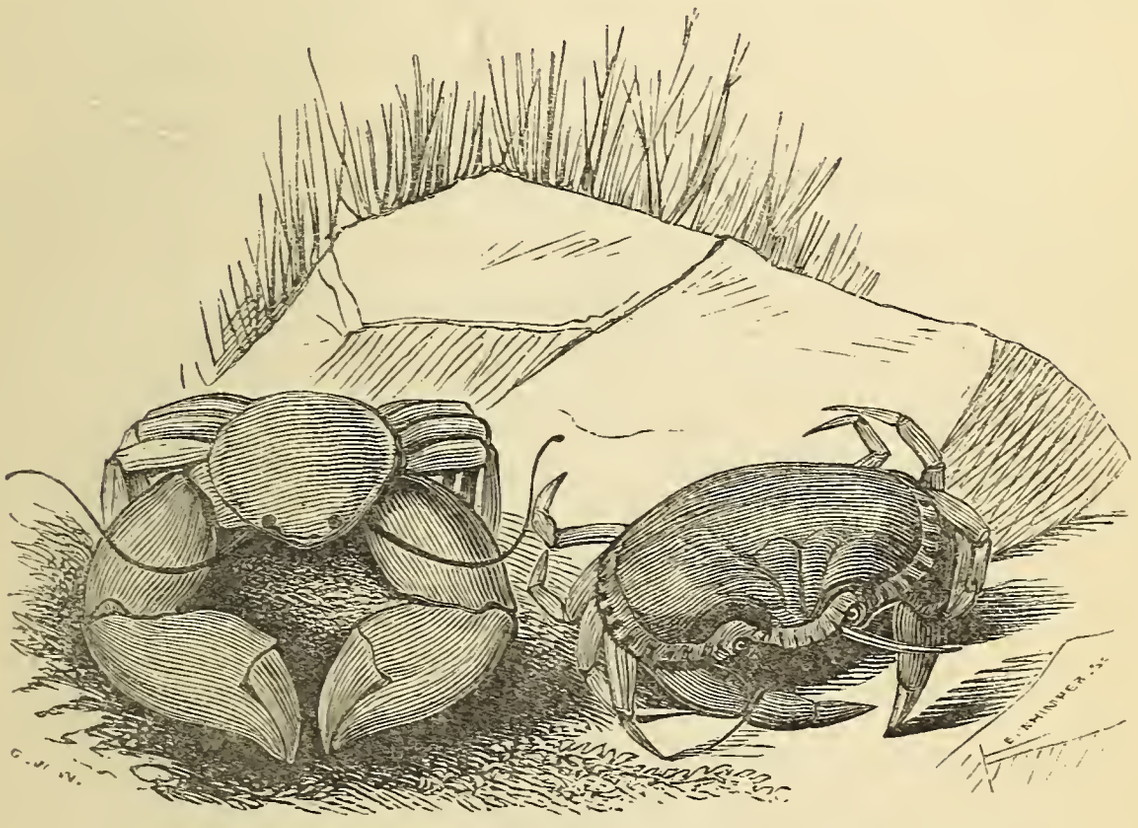
After the true fishes, the most important, zoologically speaking, are the crustaceans. Crabs are curious and



CARCINAS MÆNAS.

amusing creatures, and the great variety of species astonishes those who have not made natural history their study. The common edible crab, *(Cancer pagurus,)* with which we are so familiar in a boiled form, is the least worthy of them all in a zoological aspect. It is a tame creature, which folds its hands submissively upon its breast, and yields itself to the captor without a struggle. But the *Carcinas mænas*, which scuttles sideways along the sand, is the crab to be sought for domestication. Should

you meet one and capture him without getting a good nip from its fierce claws, you may deem yourself fortunate, for he offers battle boldly, and is not to be made a prisoner without a fierce stuggle for liberty. When caught, and dropped into the jar, he will escape unless the inside of the vessel be very slippery; and should your tank be unwisely filled to the brim, he will cling



Porcellana platycheles. Cancer pagurus.

to the zinc corner, and dropping down, make an excursion over the carpet. When dropped in, he goes in a tortuous course to the bottom, with a tremendous fizz, like a catharine wheel. The crab is easily taken by letting into the crevices which they haunt a line baited with a piece of meat. A mere piece of string is sufficient. Mænas grasps the bait, and holds on till you secure him. The fiddler, *(Portunus puber,)* a handsome swimming crab, may frequently be taken along with the mænas, as it haunts the same clefts. It is a creature

of most murderous propensities, and will wage war against every other creature in the collection. One of the most quiet, most interesting, and most harmless of the whole cancer family is the pretty broad-claw, *(Porcellana platycheles,)* respecting which Mr. Gosse gives a most interesting account in his work entitled "The Aquarium."

The soldier and spider crabs are still more comical, both in structure and mode of life. But who ever saw a spider crab trotting along on a voyage of discovery without laughing? All our childish fables, and our admiration of Harry Longlegs dancing on the window-pane, vanish before those sprawling thread-like filaments, on which a spider crab performs locomotion. Then there is the strawberry crab, which climbs up the coral branches as a monkey climbs up trees; while of all things curious in this constellation of cancer, just now so justly in the zenith, the habit of the hermit crab in fitting up a lodging for himself, with a pretty housekeeper dozing on the threshold, is the queerest of all.

HERMIT CRABS.

It would puzzle a novice not a little, if in a first experiment at deep-sea dredging, his boatman should turn out for him half a dozen large whelk shells, every one of them inhabited, not by whelks, but by a couple of creatures who seem to have entered into partnership in illegal distraint and possession. Yet there they are. Around the mouth of the shell is a mass of pulpy fleshy matter, disgusting at first sight, and which the novice would drop with horror the first time his fingers touched it. Within the shell sits a little hermit crab, a sort of mongrel between crab and lobster, his eyes starting out on stalks, wondering why he should be disturbed in his home, and menacing you with his double beak and bandy legs.

The anemone, which encloses the entrance, and serves as housekeeper to the crab, is by no means an obnoxious creature, when we know her. Just as a dead clod by the way-side expands into the ruddy glory of a summer flower, under the genial influences of sun and rain, so does this dead livid-looking mass, which we at first shudder to touch, expand—as soon as it is placed in the tank—a series of elegant flower-like tentacles, which form around it a lovely fringe, every thread of which moves to and fro in search of food.

Yet delicate as this anemone appears, the crab makes egress and ingress through the mouth of the shell, we may be sure with no very tip-toe movements ; he does not put carpet slippers over his sharp scratchy toes before blundering pell-mell over the quivering naked creature. But they seem to live jolly enough together, perhaps contributing in some mysterious way to each other's welfare, the idea of which would be still more pleasing did we not now and then wonder what has become of the pretty black-spotted whelk to whom the shell originally belonged. Was he torn from his home by the allied forces, and gobbled up at the door of his own house, to make room for the invaders ? The decision of the question is a deep-sea wonder.

Mr. Gosse, in his entertaining work on the "Aquarium," tells several amusing anecdotes respecting the parasite crabs, and especially of their occasional anxiety to change their apartments. An amusing incident of the kind is related as the result of an experiment made by Mr. James Salter :—"I have many times found hermit crabs out of their shells, in the mingled mass of a dredge haul, and on three occasions have watched the method in which the houseless creature domiciliates himself. These were the only occasions on which I endeavoured to observe the operation ; they always seemed willing enough to exhibit

their housing performances. My plan of observation was simply this—I put a naked crab into a large glass jar of sea-water, with one shell, the latter of size about proportioned to the former, and I then contemplated. In each case the crab proceeded in the same way. Appearing to *see* the shell in the distance, the animal crawled up to it for the purpose of ascertaining if the house were to let; and this circumstance he discovered, not by sight but by *touch*. Upon reaching the shell, he hooked two of his legs into its open mouth, and thrusting them as far down into its cavity as possible, commenced scrambling round the edge. He was evidently probing to discover if there were already an inhabitant. In each case the crab pursued this probing operation in the same direction —commencing on the projecting side of the shell, and ending on the receding side. Having performed this process once round, he instantly, in the twinkling of an eye, erected straight his tail, and whisked himself over the smooth lip of the shell into its tube with a rapid adroitness that was perfectly marvellous. And now in his new contrasted position he looked so funny, such at-homeishness there was in it; he was so different from the poor houseless vagabond with a drivelling tail, that one had seen miserably crawling about a moment before: he looked right up in your face, and said, as plainly as looks can speak, 'How d'ye do? here I am, quite at home already!' I never saw it without laughing.

The young new-formed crab is a very different sort of creature to the well-devoloped cancer. Every now and then he changes his coat, slips out of one armour into another, and passes through a bewildering series of changing attire. It has long been a puzzle to philosophers how such a creature can slip clean out of its crustaceous covering without leaving a visible rent, and with every joint, down to the fine-pointed claw, entire.

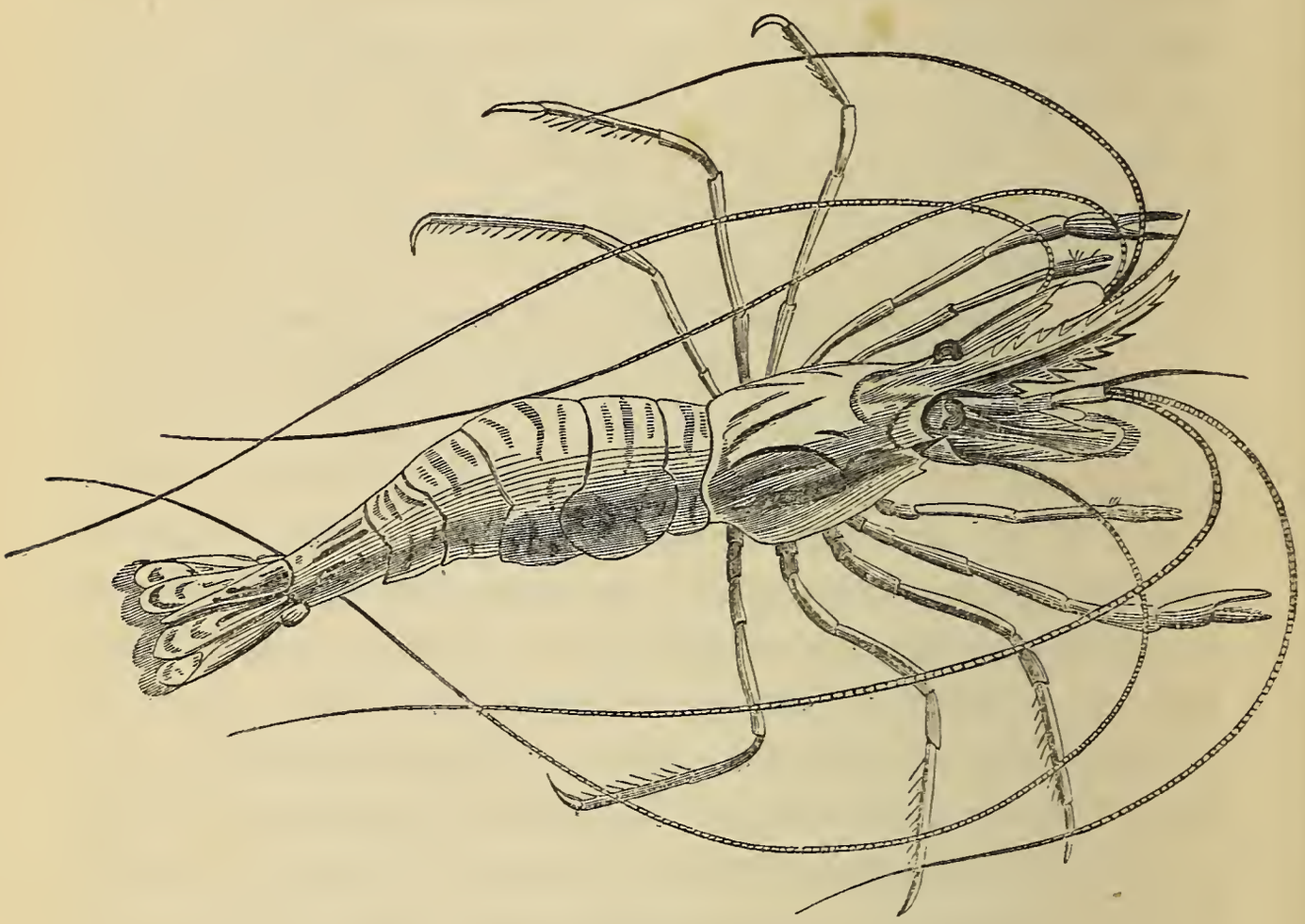
As they grow older, they perform the process less frequently, and perhaps cease at last to change coats at all. One can scarcely believe that a monster crab, containing enough meat for six hungry sailors, in a jacket as hard as limestone, can very easily withdraw from his calcareous breastplate and leggings. Mr. Broderip has a specimen which was taken alive, and on its back are oysters of six years growth. Here is proof, then, that for six years previously this individual had made no change of armour. Still we know not what he might have done if allowed to reach that primal climacteric, the seventh.

Prawns and shrimps would occupy a volume, to do them justice. Easily obtained alive, and eaten everywhere after being cooked alive, these humble creatures would stand a chance of cool treatment at the hands of the amateur, did we not here drop the hint, that for liveliness, elegance of movement, courage, and cleanliness, all varieties of shrimp and prawn are worthy of admiration, from the great lobster prawn, with its fierce pincers, down to the little shrimp, the joy of Gravesend.

Doubled up as we get them, and altogether altered in colour, by the combined effects of boiling water and red-hot poker, they convey the very remotest idea of their natural shape and character. Their natural colours are very beautiful, and a soft transparency adds much to the fascinating effect they produce on the eye as they dart up and down, moving rapidly their "many twinkling feet" with more grace than the bright *danseuse* of the French ballet. As they proceed they point forward their long horns, or antennæ, which glisten like silver threads. Then they curvet head over heels, and dart up and down again, either escaping from the attack of marauding fishes, which they keep at bay with the most playful menaces, or gamboling with each other for mere fun.

But they do fall pretty often into hungry jaws, and the stock must be kept up by a continual supply.

The crustaceans specially adapted to the purpose of the Aquarium are the following:—The sandhopper, *(Talitrus,)* common prawn, *(Palæmon serratus,)* common shrimp, *Ebalia Pennantii*, *Pagurus Bernhardus*, the common



PALÆMON SERRATUS

hermit crab, *(P. Prideauxii,) Porcellana platycheles. Portunus puber*, *Carcinas mænas*, *Cancer pagurus*, and *Maia squinado*, the spinuous spider crab. This list will doubtless be very largely extended as the system of keeping crustaceans in grouped collections is more generally adopted.

Of the mollusks and true fishes numerous remarks have already been made incidentally, and as they do not largely enter into the catalogue of generally useful

subjects, it is unnecessary for me to swell the bulk of this work by special notes upon them.

It is to the great family of Zoophytes we must continue to look for our supplies of specimens, and, after all the attractions of lively and tameable creatures, what is called *ground* stock forms the staple article. Southey unintentionally sums up in a few lines the leading attractions of the Marine Aquarium :—

> "Here too were living flowers,
> Which like a bud comparted,
> Their purple lips contracted ;
> And now in open blossoms spread,
> Stretched like green anthers many a seeking head.
> And arborets of jointed stone were there,
> And plants of fibres fine as silk-worms' thread,
> Yea, beautiful as mermaid's golden hair,
> Upon the waves dispread."

The Aquarium introduces us to new scenes hitherto hidden from our view, makes us acquainted with the economy of creatures of whose very existence many of us, not altogether unlearned in the history of the world, were previously ignorant. Their habits of feeding, of moving, and burrowing ; their battles, their changes of form, the display even of a strange intelligence, working its way by wonderful means to wonderful ends, impress the observer with an idea of the boundlessness, the variety, the adaptations, and resources of a world brimming with life, in all manner of strange forms and developments. Here we see them equipped and armed for battle against each other, the strong destroying the weak, yet each contributing its part to the preservation of the whole, just as in all other departments of Nature, the Great Balance of Perfection is sustained by incessant and intestine war ; the struggles of opposing elements, and powers, and beings, all working mysteriously in a manner independent of isolated circumstances—Nature, the Prodigal Mother, setting no value upon individuals, but

regarding tribes and races as paramount—the whole seeming confusion tending to one great end—the revolution of the mighty wheel on which the creatures are painted as signs, and in which ages are but minutes, in a revolution which is itself an eternity.

In the midst of all, sits the Everlasting Wisdom, watching, loving, and sustaining; happy we to get some glimpses of its method of working through the medium of the strange creatures, which leave the mysterious deep to throw a new radiance on our homes.